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ABSTRACT

This handbook is designed to help educators develop an environmental curriculum for their school districts. An introduction to the publication suggests ways of using the handbook and states a philosophy of environmental education. Most of the remaining pages are devoted to 20 teaching cells, or units, on various grade levels, K-12. Each unit contains an introduction and some background information for the teacher, and an appropriate activity. The topics are primarily ecological and biological in nature. Organic gardening, populations, and field ecology are among the topics covered. Each unit is designed as a starting point for the teacher and can be expanded and developed to suit individual needs. Final sections of the handbook include a listing of environmental education programs in Montana, a bibliography, a listing of resource personnel and agencies, and a survey of environmental curricula. (MA)

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ENVIRONMENTAL EDUCATION HANDBOOK

December 1972

Office of the Superintendent of Public Instruction
Dolores Colburg, Superintendent
Helena, Montana 59601

PREFACE

The publication of this Environmental Education Handbook was achieved through the cooperative efforts of many people concerned about Montana's environment and the education of the state's young people. The handbook is published in its present form for pilot-testing in selected Montana schools and, after a period of examination and use, will be republished in final form. Suggestions for refinement and revision are welcomed.

The handbook was initiated by my office during an Environmental Education Conference at Lincoln, Montana, in February 1970. At that time, an Environmental Education Committee was formed with the responsibility for developing a handbook to be used in our schools; the Montana Conservation Council accepted sponsorship of the committee and has served as a supporting organization for it.

University of Montana School of Education faculty members provided immeasurable assistance in the compilation of handbook materials. Special thanks go to Dean J. Francis Rummel for recognizing the necessity of the project and for providing secretarial and other support services, to Assistant Professor Roy C. White for serving as chairman of the committee and as editor of the handbook contents, and to Assistant Professor Ralph Allen for consulting on handbook development. Many of the teaching cells also were written and evaluated by graduate and undergraduate students in the environmental education classes at the University of Montana.

The members of the Environmental Education Committee deserve individual thanks for volunteering their valued time and talents and for personally assuming expenses involved in committee service. Committee members are Dr. Wilson Clark, Eastern Montana College; Ed Eschler of my office; Geoffry Foote, Missoula; Mavoureen Greseth, Lolo; Van K. Haderlie, Great Falls; Gary Hall, Missoula; Norman Jacobson, Missoula; Donald King, Albertson; Harold Knapp, Missoula; Charles Larson, Hamilton; Verna Rasmussen, Cut Bank; Robert Richards, Stevensville; Calvin Ryder, Great Falls, Gary Swant, Deer Lodge; Dan Sweeney, Butte; and Bob Toivonen, Deer Lodge.

Dolores Colburg

DOLORES COLBURG
Superintendent of Public Instruction

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INTRODUCTION TO THE HANDBOOK

The function of this handbook is to provide teachers, students, administrators and citizens with a reference for developing a comprehensive environment-oriented curriculum in Montana communities.

This handbook is not designed as a curriculum guide in the usual sense. Instead, it contains statements of the need for and definitions of environmental education. It also examines the causes versus the symptoms of environmental problems and the role of the schools in producing responsible, environmentally aware citizens. In short, it addresses itself to long-range goals.

The handbook may serve as a catalyst for developing a unifying curriculum theme that could be continuous from kindergarten through high school. Further development of the environmental theme must be conducted at the local level by persons involved in the formal learning process--students, faculty, administration and community. This handbook provides some suggestions for developing an environmental education curriculum, but it is only a preliminary step in that direction.

Many units or "cells" from various subject areas and school levels are contained in the handbook. The cells are not meant to be the total content for an environmental education approach; they are offered only as stimulants, as samples and as sources of information and ideas.

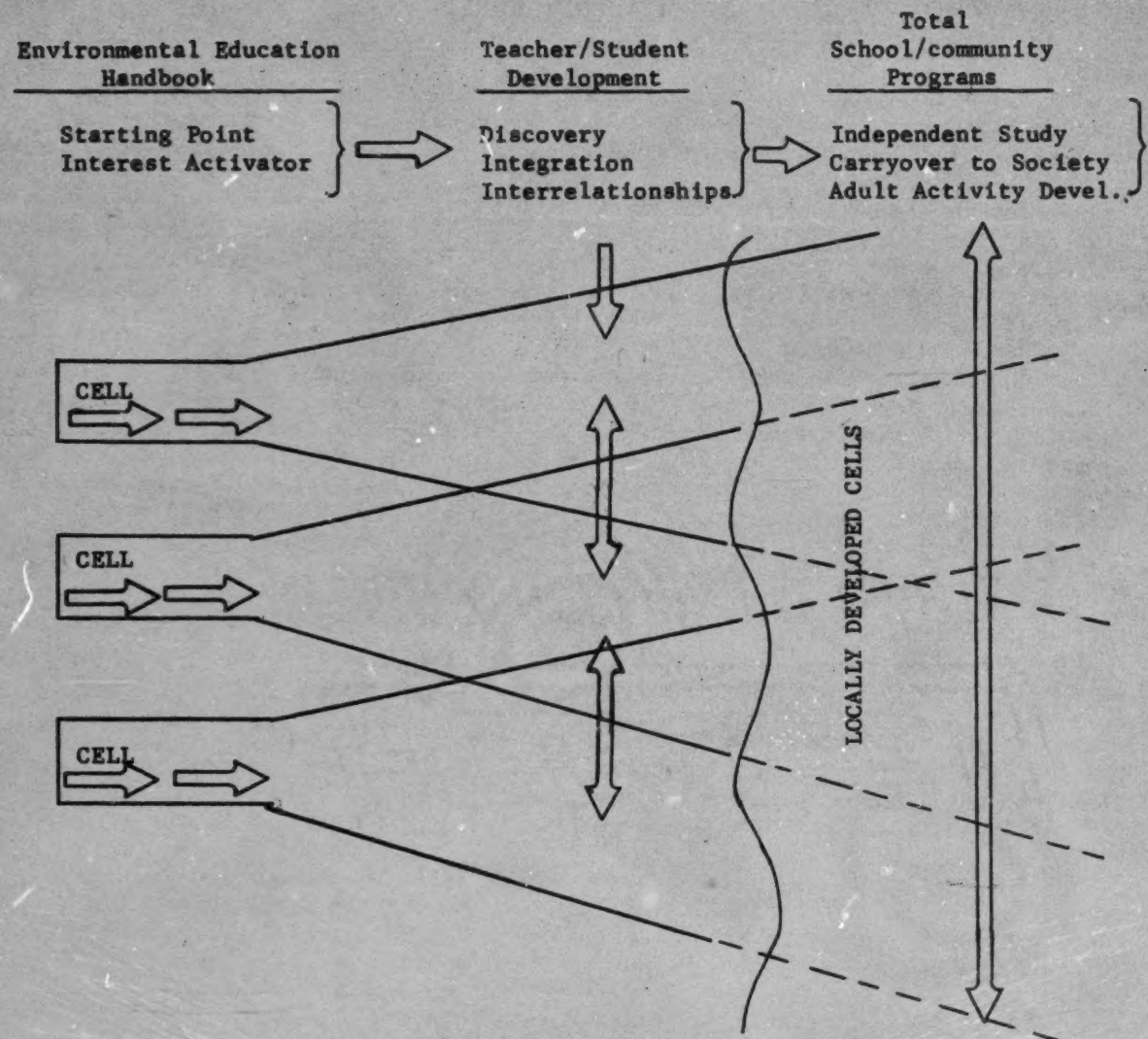
It is anticipated that teachers and students will want to develop their own cells, drawing upon suggested materials from this handbook and from other sources. This procedure should lead to the development of an environmental education curriculum acceptable for local adaptation and implementation.

In addition to the cells, this handbook contains a summary of environmental education programs in Montana, a bibliography, a listing of resource personnel and agencies, a survey of environmental curricula and a bibliography of environmental education films.

There is no "best" way of using this handbook; it prescribes no singularly proper order of activities, no rigid structure and no detailed daily lesson plan. It is dependent upon teachers who formulate their own plans and who exercise initiative in using the suggested activities.

The cooperation of the total community is required if an in-depth study of environment is to be fulfilled. Thus, it is suggested that the talents of interested community members be combined for involvement in an environmental education curriculum. Student involvement in planning is regarded as of the utmost importance as well.

The drawing on the next page graphically illustrates the concept behind the use of this handbook in a total environmental education program.


Environmental Education Handbook
Starting Point
Interest Activator
Teacher/Student Development
Discovery
Integration
Interrelationships
Total School/community Programs
Independent Study
Carryover to Society
Adult Activity Devel.
CELL
CELL
CELL
LOCALLY DEVELOPED CELLS

INTRODUCTION TO THE PHILOSOPHY OF ENVIRONMENTAL EDUCATION

If America is to develop into an environmentally literate society with an ecological conscience, elementary and secondary schools must develop relevant programs directed toward man's relationship to his total environment. The educational experiences provided by elementary and secondary schools will greatly determine the degree of awareness that future adults have--and the value judgments they make--concerning their relationship with other people, with culture and technology and with natural systems.

Confusion sometimes arises over terms relating to the study of nature and its preservation: conservation education, outdoor education and environmental education. The term "outdoor education" is used frequently since a significant aspect of nature study involves investigation outdoors, beyond the classroom. For many people, this term simply means outdoor activities such as sports, camping and hiking; however, such a narrow meaning does not embrace the collective philosophy of the authors of this handbook. The term "environmental education" best reflects that philosophy and is expressed in the following definition:

> "Environmental education consists of the recognition by man of his interdependence with his environment and with life everywhere, and the development of a culture which maintains that relationship through policies and practices necessary to secure the future of an environment fit for life and fit for living."[1]

Today, unlike a few years ago, many people are aware that man, particularly in highly industrialized nations, already has contributed much toward contamination and destruction of the earth on which he depends. The symptoms are numerous, and they have been chronicled in many publications.

While Montana does not experience the severe problems which plague many states, examples do exist of most forms of environmental decay. Specifically, the following examples of problems in Montana are cited to illustrate national problems at the local level.

A. Air pollution

Air pollution has reached disaster proportions in many areas of the nation. It is recognized as a major problem in Missoula and in other cities which have refineries, power plants, rendering works, phosphate plants, aluminum plants, smelters, incinerators and other types of polluters.

B. Water pollution

In an effort to have good water and enough of it, immense difficulties are faced in cleaning the lakes and rivers of untreated sewage, industrial waste materials, chemicals and silt.

Throughout Montana, there are examples of the national water problems. We have overtaxed or non-existant sewage treatment plants; feedlots along many streams or affecting groundwater supplies; industrial water pollution areas;

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[1] Dr. Matt Brennan and Dr. Paul Brandwein, Pinchot Institute for Conservation Studies.

heavy silt loads from irrigation water-return systems, highway construction, residential area development, improper logging and mining activities; water rationing in many cities and towns; severe salinity problems in some areas; a jungle of water claims and water rights; outmoded and multiple water distribution systems for irrigation that lead to a prodigal waste of the water we do have.

C. Urbanization and its consequences

In our nation, about 70 percent of the total population lives on about 2 percent of the land. Seventy-seven percent of the nation's youth, ages 5 to 17, is expected to be living in urban areas by 1985. This concentration of people, without proper urban planning, creates a host of difficulties. In Montana we have about five people per square mile. Yet, when one considers Billings and Great Falls alone, about 20 percent of our total population of 700,000 is in those two urban areas. If we add Helena, Missoula, Bozeman, Butte, Miles City and a few more cities, we find that, even though we think of Montana as a rural state, most Montanans are urban people with urban experiences and attitudes. They are faced with urban problems similiar to, but perhaps not yet so severe, as those of heavily populated states.

In almost every Montana city, as in most cities of the United States, we are experiencing the business shift from downtown to the outskirts, decay of some parts of the city, intermingling of industrial and residential areas, traffic and parking problems, unplanned urban sprawl on productive agricultural land. We are faced with the pressures and difficulty of supplying adequate public services (water, sewer, and police and fire protection), park development and maintenance, solid waste disposal and much more.

D. Land use and competition for use

Throughout the nation, too little thought has been exhibited in considering the possible competitive uses of land or in long-range planning for the most reasonable land use. There are exceptions, but generally land use is determined almost entirely by economic factors, by isolated private initiative with few public concerns, or by piecemeal or expedient decisions of various levels of government.

In Montana we face similar problems: real estate developers paying little heed to needed services or even to health standards; leap-frog urban sprawl often on good, irrigated farm land; interstate highway construction on farm land; the dilemma of street maintenance and traffic flows; large areas of blacktop at shopping centers with resultant runoff; house construction on unstable land; residential and other construction in the flood plane of rivers; continual zoning changes; isolated islands of unannexed industrial land within cities and demands for city services by adjacent non-city areas.

Too frequently we try to solve environmental problems by attacking the symptoms rather than the causes. For example, a symptom of the solid waste disposal problems is massive amounts of solid waste. We attack this problem by trying to get the solid waste out of sight--by burning it or burying it or locating an open dump out of view. Rather than attacking the symptom, we need to look at why we have such a large amount of waste.

The causes of the problem are not the waste but are, instead, our attitudes and our patterns of action. We waste; we worship product change and gadgetry regardless of whether or not they are improvements.

> "It is evident that some important root causes of our environmental crisis rest in our present consumer and corporate behavioral patterns, our inability to cope

with the population dilemma, and the lack of environmental policies that are responsive to an emerging ethic where man is living compatibly with his environment."[2]

We demand of our industries (and industries through advertising feed and build that demand) ridiculously extravagant use of materials in packaging; we buy on the basis of exterior superficial factors of color or chrome rather than on the quality of the product. Through our buying habits, we encourage and allow industry to build obsolescence into many products. We have little regard for other people, as shown by our excessive littering. We have not moved very far on the critically important matter of recycling materials.

The root causes of most of our resource and environmental problems lie in attitudes, social customs and political apathy to force solutions. It is seldom a valid argument that technical knowledge does not exist to solve a problem or at least to make significant progress toward solution.

As a logical extension of these ideas, we realize that, to make significant headway in the preservation of our environment, we as a nation need to alter (a) individual and consumer attitudes and behavior patterns, (b) corporate and industrial attitudes and behavior patterns and (c) governmental attitudes and behavioral patterns.

Modern school curricula must encourage the development of critical thinking, problem solving, consideration of raw data, examination or development of alternatives, understanding of cause and effect, identifying issues, evaluating solutions, developing beliefs and attitudes, building a sense of individual responsibility, becoming sensitive to one's environment, understanding the political process through which citizens may bring change, and developing plans for and carrying out actions aimed at the solution of problems.

The school can help young people to understand their total environment, to learn (through investigations of problems on their level) how to find out the essential ingredients of problems and to help them develop the attitudes and abilities that lead to responsible citizenship.

Environmental education should not be considered another subject to fit into the school curriculum; more realistically, it may be considered a philosophy of education. In this context, environmental concepts can be incorporated into the teaching-learning situation of existing subjects at every grade level. The broad objectives of an environmental education approach should contain the elements outlined below.

A. Overall goals
   1. The overall goals must be to help children
      a. become knowledgeable about their total environment (biological, physical, social, cultural, economic)

      b. become skillful in ferreting out the significant aspects of a problem or situation

      c. become sensitive to their own role in and responsibility for developing a productive and livable environment

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[2]Dr. William Stapp, University of Michigan, Report to the Kenai Peninsula (Alaska) School Board, July 1971.

d. become motivated to work constructively toward the solution of environmental problems.

B. Components of the overall goals

1. Specific areas of knowledge

a. The concept of "Spaceship Earth" as a closed system totally dependent on its own resources except for incoming energy from the sun.

b. The concept of biological (natural) ecosystems with their interdependent segments, their constant change and their dependence and effect on their biological and physical environment.

c. The concept of human ecosystems and of the cultural, social, political and economic aspects of them, in addition to the biological and physical aspects listed in (b) above.

d. Concepts of environmental management

(1) how we carry out and how we depend on the extraction, fabrication and use of resources

(2) how we have degraded the environment

(3) how we must find ways to build a quality environment and at the same time enjoy the use of resources

e. Concepts of our cultural institutions

(1) information on population problems

(2) understanding of our social, economic and political structures; how they work, how they interact and how the individual may responsibly act to alter and improve their effectiveness.

2. Specific areas of attitude development

a. Assisting teachers and pupils in developing a concern for and a sensitivity to the quality of the environment, both natural and man-made

b. Developing a sense of individual responsibility

c. Fostering the growth of a desire--a motivation--to help resolve environmental problems.

3. Specific areas of skill development

a. Developing in teachers and pupils investigatory skills involving critical thinking through

(1) identifying and defining a problem

(2) collecting information about the problem

(3) evaluating that information as to validity, relevance, bias, emotionalism and accuracy

(4) devising experiments, studies or investigations, collecting data and properly using that data to draw conclusions or to make sound generalizations.

b. Developing action skills in problem-solving through
   (1) using the results of the investigating skills

   (2) becoming well informed

   (3) developing and stating alternatives

   (4) devising a plan of action

   (5) putting that plan of action into operation to contribute toward achieving the desired change.

ENVIRONMENTAL/ECOLOGICAL STUDY (K-3)

Judith Herber

I

Introduction

Good science and social studies programs should include the total environment and should describe man's environment on earth and his relationship to it. Man must develop a "social conscience" about the world around him.

Recent probes into outer space have revealed to man just how precious our planet Earth and its resources are. The probes brought to light the barren and lifeless rocks and dust of the moon and the poisonous gases and hear or cold where man cannot survive.

The place to begin developing the "social conscience" or an awareness is in the lower elementary grades or before. It can be taught by the child's exploring his own environment--home, school and the habitats of animals around him. His responsibility to his environment should be stressed and appreciation will soon develop.

Very often children become so involved that they motivate their parents to awareness. These same children, when they continue to have a good program in environmental education, become more and more aware of their surroundings and what man is doing to them. The children grow to be responsible adults who will be motivated to action.

The outline of the program which follows sets up concepts and problems for discovery. The activities for discovery are suggestions based on observing the environment and learning in an outdoor laboratory situation. This was not meant to be a complete and structured guide for the teacher. Rather the teacher must use his own ingenuity and resourcefulness. The outline was designed as a unit to be used with the regular science and social studies program.

Kindergarten Program

Theme: Animals (including man) and plants change with the seasons.

I. Concepts to be developed
   A. Seasonal Changes
      1. Autumn
         a. Leaves change color. Then they fall off the branches.
         b. Different kinds of plants make different kinds of seeds and nuts.
         c. We use seeds and nuts to plant new plants and trees, to eat, for decoration.
         d. Animals eat seeds and nuts.
         e. Seeds and nuts travel in different ways.
         f. Animals get ready for winter in many different ways in autumn. Some eat for hibernation. Others migrate to a warmer place. Some gather nuts and seeds to store for winter.
         g. People must wear more clothes. Sometimes people gather seeds and nuts for winter too.

2. Winter
   a. The trees have no leaves. Some trees stay green all winter.
   b. Plants are dead or dormant.
   c. Animals are hibernating, or, if awake, are eating the things they have stored or the seeds left on the plants.
   d. People wear warm clothes. They have to heat their homes.
   e. The weather outside is cold and snowy and windy.
3. Spring
   a. Some signs of spring are grass coming up, small green plants, buds and small leaves on the plants.
   b. The weather is warmer. Sometimes it is very rainy in the spring.
   c. Animals come out of hibernation. Birds return from the south.
   d. Baby animals usually are born in the spring.

B. These additional concepts should be developed (especially for the outdoor area).
1. There are living and nonliving things.
2. There are more kinds of living things outdoors than indoors.
3. Living and nonliving things are found near each other, sometimes on or in each other.
4. You can recognize many things by the sounds they make.
5. Some things occupy more space than do other things.
6. Light from the sun does not reach some parts of the earth.
7. More plants grow where there is sunlight.

C. Some problems and discussion questions can be developed for the children.
1. What kinds of living things do we see outdoors?
2. What sounds do some living things make?
3. What things which are living do we find outdoors?
4. What sounds do some of them make?
5. How big is the biggest rock at each station where there are rocks? What size is the tiniest piece of rock at each station?
6. Which station has the most light? Which is the darkest? Where do you find most plants?
7. Which living things take up the most space?
8. How can you grow plants indoors in a dark corner if these plants are found growing outdoors in a sunny area?
9. How could more sunlight reach some of the shady spots outdoors?
10. How could you learn whether some crowded plants which grow outside your school would grow better if they were not crowded?
11. What unpleasant outdoor sounds should be stopped?

II. Activities
A. Take nature walks in the spring, winter and fall. Discuss the birds and animals that you see. Look at the plants and trees.
B. Discuss the home environment. How do people change with each season?
C. Make a leaf collection. You can preserve the leaves or do leaf rubbings.
D. Discuss how pets change when the season changes, for example, how a dog's or cat's fur becomes thicker before winter, and how the pet will shed the fur in the spring.
E. Make a seed and nut collection.

First Grade Program

Theme: Birds and Mammals (including man) provide homes for their young and help to serve their daily needs.

I. Concepts to be developed
   A. The nesting and feeding sites of birds are the same. A bird won't build its nest where there is no food.
   B. Birds use many materials in building nests. However, certain kinds of species of birds will use the same kind of nesting material.
   C. Many animals use enlarged holes or natural cavities in trees or the ground for their nests.
   D. In order not to disturb nesting birds, winter is the best time to study nests when they are easier to find. Note the type of habitat, exact location, size and shape of the nest. Use books for finding what kind of bird made the nest.
   E. Animals use their homes for many purposes.
   F. A wild animal's home serves many of the same needs as do our homes.
   G. Some baby animals need more care than others.
   H. Animals' bodies adapt to their habitats and to obtaining particular kinds of food.
   I. Certain animals live in certain habitats. Habitats may be changed by man.
   J. Although the wind usually blows from the west, it frequently changes direction.
   K. Trees, such as, pine, spruce, hemlock are green all year.
   L. Trees change the temperature where there is shade.

II. Some questions and problems for the children
   A. How many different kinds of animals' homes can you find? Where are they?
   B. What are some purposes for which the animals use their homes?
   C. How does a wild animal care for its young?
   D. In which places at each station does the wind blow strongest?
   E. Where is it cooler on a warm day, in the shade of a tree or in the sun outside of the tree's shade? Where is it warmer on a cold day?
   F. How can we make certain that even though we use evergreen trees for Christmas that we do not run out of Christmas trees?

III. Activities
   A. Keep a record of the birds that live in the area. Children can keep a record at home of the birds they see there.
   B. Make a collection of nests. Examine what materials were used in their construction.
   C. Complete the incubator lesson. Compare chickens with wild birds.
   D. Discuss how a dog takes care of its puppies; how a cat takes care of its kittens. How do your mother and father take care of you?
   E. How many different kinds of evergreen trees can you find?

Incubator Lesson

This is a short lesson to acquaint the teacher with the operation procedure of an incubator and the development of a chick from conception to hatching. The books listed will be helpful to the teacher and the students.

The lesson may be used and developed to various degrees of difficulty at any grade level. The use of the incubator is included in the first-grade list of suggested activities in the Conservation Curriculum Outline.

From Egg To Chick

Most of the eggs that a chicken produces are consumed as food by us. However, if the sperm cells from the rooster are allowed to join with the egg cells of the hen, then something quite different from the formation of an egg begins. The first step in the development of a baby chick has begun.

The white and shell of the chick are added just before the egg leaves the body of the hen. If you were to crack open the egg at this point, you would find that it would look just like any egg that you would buy at the grocery store except that it would have a tiny white spot on the yolk. It is from this spot that the chick will develop.

The hen sits on the eggs in order to incubate or keep them at the proper temperature. If we could look inside the egg after five days, we would be able to see the forming of the wing, eye, heart and ear. At seven days, the beak, feet and tail become evident. By the tenth day, the partly formed chick begins to move. At the end of the second week, the chick has used up most of the white part of the egg. For the last week of his development, he will make use of the yolk for his development. By the end of twenty days, the chick has used practically all of its yolk and is just about ready to enter the world on its own. The twenty-first day marks the end of the waiting period.

The chick now begins the long process of pecking his way out of the shell. After three or four hours, the egg finally splits and the fully developed chick is now capable of finding and eating its own food.

Incubating Eggs

In setting up an incubator, the water trough should be filled with warm water at all times. This assures proper moisture content for the eggs. Usually there is a hole for eyedropper addition of warm water into the trough.

Insert a thermometer in the base and let the incubator warm up for 24 hours to get it completely prewarmed for the eggs. During this period you will be adjusting for ideal temperature of 102°.

It is critical that the temperature go no higher than 103° and no lower than 97°. The incubator should be located away from radiators, drafts and sunlight so that an even temperature may be maintained throughout the incubation period.

The incubator is now ready to use for the hatching of chicks. Eggs should be placed with the point end facing the center. The air sac and head of the chicken are at the large end of the egg.

Clean, fresh, fertile eggs should be obtained from a local hatchery and should be candled by the breeder to assure maximum fertility. Even if the breeder supplies you with a group of "guaranteed fertile" eggs, there are likely to be disappointments and these should be anticipated. Consult the yellow pages of the telephone directory for information on hatcheries.

Mark each egg on one side with a pencil. This is done so that you can always tell which eggs have been turned. The incubation period for chicken eggs is 21

days. During this time, the eggs should be turned at least twice each day, once in the morning and once at night, although three or four times is preferred.

When turning the eggs, switch them around in the incubator to account for any variations in temperature. Don't turn the eggs after the 18th day.

Candle the eggs by placing them over a light bulb in a darkened room. If they are infertile, do not place them back in the incubator.

Humidity is an important factor in successfully hatching an egg. Check the water level constantly and when the level is down, add warm water with the dropper through the hole provided. Weather conditions will greatly affect the relative humidity in your incubator. If the moisture loss is too great, a poor hatch will result and the chicks will stick to the sides of the shell. If there is too much moisture, on the other hand, this will also result in a decreased hatch. The relative humidity should be around 56 percent or 57 percent.

An incubator being used for classroom observations should be taken home on weekends and holidays. This is done so that the temperature can be watched and the eggs turned regularly. When taking the incubator home, it should be wrapped in a large towel or blanket and transported as quickly as possible. Don't be alarmed if there is a 10° to 15° drop in temperature. If this drop is only for a short time, it will not affect the hatchability of the eggs.

After 18 days, the eggs should not be turned and the incubator not opened. Chicks will start to pip (break out of the egg) at around the 19th day. All chicks which are going to hatch should be out of their shells on the 21st day.

If, however, during the incubation period the eggs were chilled, or you ran into operational difficulty, your hatch may be delayed. You should not expect healthy chicks to hatch beyond the 22nd day.

When the eggs have hatched, lower the temperature to approximately 95° for about 24 hours. This allows the newly hatched chicks to dry off.

Chicks should then be removed from the incubator and placed in a brooder which is nothing more than a larger container with a light for heat. Food can be bought at any feed and seed store.

Some reasons for a poor hatch:

a. infertile eggs
b. temperature too high or too low
c. eggs not turned often enough
d. high or low humidity
e. too much handling
f. weak parent stock
g. oxygen starvation
h. improper room ventilation
i. weak embryos which died during early incubation

Further information may be found in the following books:

Schloat, Warren, Wonderful Egg, Scribner, 1952
Ludwig, Helen, All About Eggs, Scott, W.R., 1952

Selsam, Millicent, Egg to Chick, Young World, 1946
National Science Teachers Association, Living Things, Vol. I., Teachers Publishing Corporation, Darian, Conn.

Second Grade Program

Theme: Plants of any community are dependent upon their neighbors (animals, soil, other plants) to meet many of their needs. How can we, in turn, help the plant community?

I. Concepts
- A. Many animals depend on plants for food.
- B. All green plants make food.
- C. Certain animals can be discouraged by destroying their plant food.
- D. Certain animals can be encouraged by planting certain foods.
- E. Soil comes in part from rocks which crumble.
- F. Wind, water, heat and cold act upon rocks to weather them. Soil is composed of minerals weathered from rocks, living and dead organisms, water and air.
- G. There are many different kinds of plants. Each has its own type of leaf, stem, roots, branches, etc. Each is adapted to live in its environment.
- H. A close relationship exists between plants, animals, soil and water.

II. Some questions and problems for the children
- A. What evidence can you find that animals use plants as food?
- B. What parts of all plants are green?
- C. What evidence can you find that changes have taken place in some rocks outside?
- D. Where can you find examples that the roots of plants keep water from washing soil away?
- E. What kind of food would you plant to attract field mice, rabbits, gophers?
- F. What kinds of plants would you grow to attract humming birds, butterflies, moths?
- G. How are plants and animals related in a cycle? (Energy, food cycle)

III. Activities
- A. Take a trip to the dairy to observe the energy good cycle.
- B. Pull up different kinds of plants. Look at the stems, leaves and roots.
- C. Plant seeds, bulbs, roots.
- D. Discuss and experiment about what happens to plants when they are kept in the dark, in the sun, when not given enough water, when given too much water, when planted too close together.
- E. Make a terrarium.

Energy Food Cycle

I. Cows and Cattle
- A. Why they are raised
  1. Milk
  2. Food
  3. Other products

B. Types of cows
   1. Dairy
      a. Holstein - Friesian
      b. Jersey
      c. Guernsey
      d. Ayrshire
      e. Brown Swiss
      f. Others
   2. Beef
      a. Hereford
      b. Shorthorn
      c. Aberdeen-Angus
      d. Brahman
      e. The Santa Gertrudis
      f. Others
   3. Dual-purpose
      a. Milking Shorthorns
      b. Red Polls

(The outline on cows is to serve as a guide in development of a unit on farm animals.)

II. Dairy farming
   A. The farm
      1. Calves
      2. Food
         a. Grains
         b. Hay
      3. Care
   B. Milking process
      1. By hand
      2. By machine
   C. The plant
      1. Pasteurizing
      2. Bottling
   D. The delivery

III. Food chain
   A. Sun
      1. Provides the source of energy for producing food
   B. Precipitation
      1. Provides water which in turn supplies the soil and plants with an essential ingredient
   C. Soil
      1. Provides plant and animal life a home
      2. Provides plant and animal life with nutrients essential for growth
   D. Plant life
      1. Provides animals with food
      2. Provides soil with organic matter
   E. Animal life
      1. Provides food for man which is essential to his growth
      2. Provides fertilizer for the soil which makes the soil more productive
   F. Milk
      1. Provides necessary food ingredient for the growth of man
   G. Man

Third Grade Program

Theme: Plants and animals which live in bodies of water (such as a river, lake, or pond) are very dependent of each other and their physical environment. If the bodies of water are not polluted they can continue to help serve many of their communities' needs.

I. Concepts
   - A. Much of the earth's surface is covered by water. Many different kinds of plants and animals live in water.
   - B. Study the method by which water follows a cycle.
   - C. Aquatic plants and animals have special adaptations which make it possible for them to live in water.
   - D. Most aquatic animals are able to get the oxygen they need from the surrounding water.
   - E. Tiny animals which are suspended in water depend on small plants for food. These small plants and animals are called plankton, and provide food for many larger animals.
   - F. Man makes use of streams, lakes and the sea to provide many of his personal and community needs.

II. Some questions and problems for the children
   - A. How many kinds of plants and animals that you can see or find are living in the pond?
   - B. How many ways can you think of that man uses water?
   - C. What would happen if the plants and animals did not get oxygen?
   - D. What would happen to the larger animals if the smaller animals and plankton would be killed by pollution?
   - E. What are some adaptations that animals and plants that live in the water have that ones on land do not?

III. Activities
   - A. Microscope unit. Use pond water.
   - B. Field trip to the river to study what animals and plants inhabit the river or its surroundings.
   - C. Check for pollution in the river.
   - D. Build a balanced aquarium.

Discovery Guides and Evaluation

Some type of discovery guide should be prepared to help the child use methods of problem-solving. In this way this study can be individualized more easily.

It could be as simple as the child keeping a leaf or weed collection in a scrapbook. Pictures of animals, plants, birds, etc., could be added to his scrapbook. In second or third grade the child might keep a diary or log with pictures from magazines, things he has drawn or collected in his outdoor experiences. He may want to do a special report or go more in depth on a particular phase of the study. An example of a study guide for kindergarten through third grade is given on page 18. It consists of finding the variety of colors of flowers in a field near the school, the school lawn, or a florists' shop. It was taken from Project S.P.R.U.C.E.

Children could help you evaluate your program. What did they enjoy the most? What would they like to know more about? What new experience could we do next time? What did they like least?

The curriculum committee for the conservation/ecological program could help too. They could be constantly studying the program to see which parts are outdated, which parts need additions or deletions, which new material could be added.

Tests could probably be presented from this material, but should depend on the individual teacher. For the younger children, tests usually are not necessary. These children should come to appreciate the outdoors without having to remember for a test.

Sample Discovery Guide

Name _____

Investigation: What colors are the flowers outside?

1. Find a flower which is in bloom. Do not pick it. Which of your crayons makes a color that looks like the flower? Color this circle with that crayon.

2. Now color the leaves with the crayon which looks most like the leaves of this plant.

3. Find four more flowers, each of a different color. For each of these four flowers pick out matching crayons and color a circle and the leaves.

Discussion:

1. Which parts of these five flowers are the same color?

2. Which parts are different colors?

3. How can we use flowers to make our school look more attractive?

Summary

The interrelationship of man to his environment is the principle concept of this program. The guided outdoor experiences offer the child learnings and understandings which he could not otherwise appreciate in everyday life.

This environmental/ecological study is outlined. Each particular school or teacher could build it much further into a resource unit or curriculum project. Pupil involvement and experience should be stressed throughout this open-ended program. Books and other audiovisual aids are not listed because different schools have different aids and funds available.

DEVELOPING AN ENVIRONMENTAL ATTITUDE IN THE PRIMARY SCHOOL CHILD

2

Mary Schauer

The purpose of this section is to provide ideas from a number of sources, including some of my own, on how to develop an attitude of appreciation of the environment in the primary school child. It is my belief that this must be done in an all-inclusive manner by integrating it into all subjects in some way. After supporting my thesis with research on teaching attitudes and values, I will provide some suggestions as to how to include an environmental study in the various classes taught in primary grades.

Bernice J. Wolfson, in Values and the Primary School Teacher, asserts that in the primary grades, values are learned through identification with others and accepting their values; through questioning; by considering the consequences of alternative choices; engaging in decision-making; and by becoming aware of one's own feelings and those of others (for example in literary characters or creative dramatics). The classroom can provide a wide variety of activities that would make the environment real and vital to the child. If an adult must be sold on an idea then so must a child and even more so the child because his experience is limited. Before he can value something he must experience it and his need for it.

Exposure is not enough to create a value. If, as the author has pointed out, a value is learned through identification with other persons' values, then in the case of the value of a beautiful environment preserved for generations to come, the teacher's influence might be very great. It is, in this case, her responsibility to present activities and circumstances in which the child can arrive at his own value system. Her responsibility is to teach the child to clarify issues, varify the information on which the value is based, and analyze the logic inherent in the solution of the problem. As the child grows older he would be more capable to carry this out but to the extent he can do it in the primary grades, he should be guided to this end.

According to Michael Scriven and writer Melvin Ezer, author of Value Teaching In The Middle and Upper Grades: A Rationale for Teaching, not Transmitting Values, the individual has a right to determine for himself what is right and wrong concerning the basic issues of conduct. The school's responsibility, then, is to present alternatives and to describe modes and consequences, and to teach skills that are necessary to evaluate these alternatives. In this way the student's value is strictly his own.

Questioning, another method by which children acquire values, is important. (1) When the student makes a seemingly simple question about his environment -- for example the teacher should be aware of his interest and use this opportunity to raise more questions in his mind and to clarify what is unclear -- and (2) when the teacher's questions also are recognized as important. The types of questions she asks can lead to discovery or can end a searching topic immediately.

Another means Miss Wolfson mentions is being aware of one's personal feelings and those of others. Feelings are very important in value decisions -- they cannot simply be intellectual or they will fade with the memory. The teacher can develop many situations close to the child's needs and experiences to which he can relate, thereby involving his feelings. For example, he reads various stories in which he can associate with the characters and can

see the reality of the animal's world. In this case it is important to distinguish the reality from the fantasy such as is in Charlotte's Web by E. B. White, where Charlotte, the spider, takes on human characteristics with which the child can associate.

John Jarolimek and Helen Walsh have developed a method of teaching values which they believe is the most effective. This is the method of clarifying the issues. They suggest that in questioning, the teacher should select questions that only the students would have an answer for and ask them non-judgmentally so the students come to their own conclusions. Make certain that in class discussions the dialogue is not a debate but a clarification of ideas which the children bring up. An example of a dialogue (adapted to this environmental issue) would be:

> Student: "I hate mosquitoes."
> Teacher: "You have never liked them?"
> Student: "I don't know."
> Teacher: "Oh."

This topic of mosquitoes later could be included in a lesson in which the student who questioned this leads the class with research he had done on the function of the mosquito, etc., but the purpose of the preceding dialogue is merely to clarify in the student's mind exactly what he means.

In his book, The Inner-City Classroom, R. D. Strom makes a statement which is applicable here.

> "Our task is not to invade and conquer values like hostile territory...but to help clarify values which are confused, then to give incentive and direction by which the values can be achieved."

The following includes some suggestions for classes regarding environmental appreciation. We Like Bugs by G. P. Conklin is suggested with The Wind in the Willows by Kenneth Grahame as good reading materials to raise value questions and sort reality from fantasy. Teachers can lead students to discovery of indoors and outdoors through the use of aquariums, terrariums, pets, outdoor excursions, field trips, etc. Simple interaction with people, talking, listening and writing can help. Other reading such as poetry also can bring a different insight. Pictures, films, or slides often make the situation more real when an outdoor excursion is not possible. In these many ways, the child can see for himself that living things are important.

Frank Lloyd Wright has shed a different light on the meaning of nature. He would use nature to teach design, pattern, rhythm and beauty, pointing out that nature builds with patterns and movement; that there is an interplay of sun and shadows, sound and stillness. He shows that it builds with color, design, pattern, movement. This type of outlook on nature could lead to many interesting learning experiences. For example, the teacher could use nature as a stimulus to her art class by teaching line design, pointing out contrast in nature, etc. This could accompany a field trip and/or science class. Music class also could be involved to provide the students with listening experience in natural surroundings. They could write music about it or listen to what composers have written about nature's settings. Reading might accompany an outdoor excursion or might bring the outdoors into the classroom. This might include poetry written about nature or stories the student might find about nature. This experience might evolve into a student developing his own creative writing about nature.

There are infinite opportunities available to explore. In "The First Grade Scientist," an article from Science and Children, the author states that the child believes what he perceives. A teacher then should use ideas which can be found and developed through observation and manipulation of actual objects from his environment such as the above experiences.

Some specific experiments which might be conducted for a science class are suggested by V. E. Schmidt and V. N. Rockcastle in Teaching Science with Everyday Things. They would include, for example, a study of "wise water use." Each child would study how much water his family uses over a two-day period. He would experiment with how much water the toilet, bathtub, washing a car, watering the lawn, cooking, washing dishes and clothes uses. Each experiment has specific directions. The student also would be told of water available in his community and the population of the community so he might estimate what the whole community would use over this period.

Another experiment is called "Fish-less Aquariums." This includes a trip to the pond where each student would get a glass of pond water and silt or sand from the bottom and pond plants and animals such as snails to watch the water clear. Various questions are asked about the animals, water and other processes they've watched. The authors suggest that when the lesson is completed the students return to the pond to replace the animals and water in the pond rather than wash it down the drain.

When the student has personal experience with nature in an educational setting providing an opportunity to acquire values, the student will have a clearer idea of the purposes and value of his natural surroundings. The child is guided to an understanding and possibly a love of nature that is impossible to achieve through reading books or hearing lectures on how to care for the environment.

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MEETING THE ENVIRONMENTAL CRISIS 3

John McKenna

I. Background

After serving 6 years in the U.S. Marine Corps, I went into the teaching profession on the junior high level in Wilmington, Delaware, but I wasn't satisfied. I couldn't incorporate enough ecology into my classes. Consequently I took a position with a private school and initiated a reasonable facsimile of a conservation-oriented program on the sixth grade level at The Tatnall School. After two years at this school I was recruited by Mr. John Comfort, headmaster of the Graland Country Day School, Denver, Colorado. He wanted me to set up a departmentalized science program for grades 4 to 6 and he very much wanted me to continue the environmental studies that I had begun in the East.

After three years at this school I am sometimes doubtful whether our curriculum has enough physical science, but nobody has questioned that facet as yet.

It was quite a challenge to leave the Middle Atlantic coastal plain and piedmont regions and find myself at the foot of the Rockies. But, after taking some week-long seminars from Dr. Betty Willard, Thonne Ecological Foundation, Boulder, Colorado, I felt very secure in starting an environmental study. I chose the Rocky Mountain National Park as my outdoor lab setting and I was given assistance by Mr. Tom Thomas, Chief Naturalist. However, he could only give me an area to work and apologized for not having any curricula data or rangers available.

II. The Outdoor Lab Site

The study area in the Rocky Mountain National Park is located around a man-made lake in the Glacier Picnic Area at approximately 8,400 feet. There are two fast-flowing streams feeding into the lake with many old beaver impoundments and new dams. A hard-surfaced road divides my area into a coniferous slope of Lodgepole Pine and Engleman Spruce, and another slope predominatly Aspen. The two slopes are lateral moraines which put our area in the middle of a glaciated valley with excellent views of cirques. After spending three weekends studying and observing the terrain I concluded that I could teach the following.

III. Teaching Principles

A. Basic Geology--I have used a geologist who has offered his time for our field study. He has been very well received by the children.

B. Recreational Values--Teaching recreational values of such an area is much more effective when the students are taught at the site itself.

C. People Impact--This is obvious as we move throughout the study area and see the filth left by homo sapiens (Surinus Americanus). I showed the students the human browse line in and around the campgrounds and picnic areas which are caused by people too lazy to walk one hundred yards away from the campground where there is plenty of wood lying on the ground.

Erosion caused by people trampling vegetation on hillsides as they refuse to use trails designated by the authorities also is evident. I make it a point to show erosional damage caused by mechanized vehicles. Even horses using the same trails year in and out can cause very severe damage which is evident in the Rawak Wilderness area northwest of Ft. Collins, Colorado. Here the trails must be shifted before they become severely rutted.

I was guilty of causing erosion on a hillside in the study area when I led sixty students and twelve adults down a slope on a new trail. As I was back tracking I couldn't believe my eyes when I saw the rut we left in that precipitous slope which had little or no vegetative cover.

On the Alpine, of course, we stress the delicacy of the vegetation and what people could do if they ran their vehicles onto the meadows.

D. Aesthetic Awareness--I climb up a ridge to a vantage point where we have our lunch. After lunch I point out the beauty of the area and make it known that we're only thirty minutes from the picnic area but we would be the only humans to climb that particular ridge this year and maybe years hence.

Tourists very seldom visit this park and other natural wonderlands except from autos. In fact, they seldom get out of their cars except to eat, sleep and use the lavatory. I try to show my students that the real beauty of our parks and national forests is away from the roads and not very far at that.

Winter also is a time of beauty when one can glide over the snow-covered trails on his cross country skis or snowshoes. I have organized cross country ski parties when one can transfer much philosophy, notably around a warm fire. I also painstakingly tell participants how adverse the "clackety clack" of the noisy snowmobile and trailbike are in this setting, e. g., noise, odor, erosion, tree and shrub damage, littering, making inaccessible areas accessible and even robbery of back country cabins.

Quiet, peace, clean air, clear bubbling streams and green hills can be compared to the inner sanctum of a church, that is, a place where man can meditate; a place where he can reflect upon himself and the world around him. I continually stress that these areas must be kept just as they are today in order that our children may see it as we are seeing it today.

E. Water--We review the hydrologic cycle as we observe a frothy bubbling mountain stream and go over its importance in the web. I have found that one can't review these principles enough. I have the children take samples of the stream's fauna, flora and water. I am not greatly concerned with the children identifying stream life, but I want them to come away with a feeling that they know the importance of these animals and plants. The better students do take pride in their identification and find it fun. Even though we have had food chain study in the classroom I like to go over these chains in the outdoor laboratory.

F. Sun--Photosynthesis is a process that I require <u>all</u> sixth grade students to know without hesitation. We slowly go over the importance of the sun's role in the web. Next year, I will include the Greenhouse and Ice Age theories as I only mentioned them this past year.

G. Air--We often have interesting discussions on air as we compare the Rocky Mountain air to Denver's, which often leaves much to be desired.

H. Soil--Our students take soil samples from different areas in the study plot, beaver pond, conifer and aspen slopes. They compare this soil's texture, color and pH. Samples of the plains and their own backyards are used in the above comparisons. Soil layers are shown at a previously dug site.

I. The Beaver Pond--Here I compare the beaver to man in their respective dam-building ways. The beaver is an excellent animal to study. The students can readily compare the area before the beaver's appearance, during his stay and after the beaver leaves. Plant succession is best taught here near the beaver's environment. Children love to collect and the beaver pond offers an excellent place. Former students have donated traps and skulls. One student even took us to his ranch 35 miles away and gave his class, teachers and parents a dissertation on this animal which was on par to a college wildlife major. I required my students to watch a TV special on beavers.

J. Aspen Slope versus Conifer Slope--Here I show the students the differences between these slopes, taking into consideration fire damage, soil, degree of slope, water holding capacity of the soil, amount of sunlight, ground litter and the availability of animal food. The children come home calling the Aspen slope an outdoor supermarket.

K. Producers-Consumers-Decomposers--One of our worksheets is devoted entirely to a compilation of the above, made by the students.

L. Timber--Bore sampling makes our field problem fun as we probe the forest's age. Our entire study plot has once been burned; thus, the students can readily see the long process of reforestation. Plant succession is shown again on the forested slopes.

M. Plant Succession on Boulders--There are boulders on our study plot that show plant succession from the lichens to young Ponderosa and Lodge poles.

N. Fallen Logs--I use these logs to show and explain decomposition. Here I allow the students to probe into the log for animal specimens.

IV. A Day Spent on the Alpine

As a result in taking Dr. Betty Willard's week-long field seminar on the Alpine I find myself taking my students for field study in this intriguing life zone.

A. Study Area--Located on Trail Ridge at 12,000 in Rocky Mountain National Park

B. Ecology principles given to the students

1. Climate controls the growth in this ecosystem .

2. Plants and animals adapt in their own peculiar ways to this harsh environment.

3. The Alpine climate is inhospitable to man.

4. Show the students the fragility of the tundra. People-impact scars are evident.

5. Point out the geological aspects of the tundra; fell fields, monument rock, frost levels, weathering, cirques, soil composition.

6. Identify fauna and flora. Point out predator-prey relationships, especially the weasel and gopher situation. Gopher damage is very evident.

7. I terminate this interesting day with a visit to the national park's Alpine museum that displays some animals and plants that we didn't see during the day.

This is a very interesting day for the students and for me. I always try to have lunch on a site that gives the student a scenic view and an appreciation of the harsh climate, especially if the wind is blowing and the snow is biting their faces.

V. The items below are some tidbits I have gathered in making or planning better field studies.

A. Plan your trip to the smallest detail, taking nothing for granted.

B. Have good hearty meals and warm sleeping quarters.

C. Make a classroom available large enough to accommodate your group and the audiovisual aids you plan to use. Appoint a responsible student to be your audiovisual assistant.

D. Have a nightly meeting which can be used to clarify any problems. Incorporate good films at this time. I used "Cry of the Marsh," "Trout Unlimited," "Life of a Trout," and "Life in a Pond."

The "Cry of the Marsh" stimulated a serious discussion involving even the parents.

E. Physical recreation should be planned for this exuberant age group. We are fortunate to have the use of an excellent swimming pool.

F. Choose carefully the adults and teachers going along as "extras." Try to find persons who are motivated in this area of education.

G. Always work with the students even when you are bone weary. They appreciate you more when you are there in the grim water and snow.

H. Avoid obvious inclement weather periods unless your study is related to a winter period.

VI. Environmental Education Plans for the Middle School Grades 4-6, 1970-71

Objective--To find a nearby outdoor study area easily accessible for regular class periods, which will be two 90-minute periods each week. This environmental study will run concurrently with the regular science curriculum, a no-text laboratory-oriented program.

Proposal--To use Cherry Creek, which is located only five minutes from campus by auto. I would use this creek for the nine school months with the summer optional for those students who desire to continue their studies.

Why Cherry Creek?

First, it is close to the campus and all the children are familiar with this creek. It is unique in that its banks are covered with native flora even though some of the native animals have disappeared. This study area is bordered by the high rise apartment dwellings of metropolitan Denver with more than 1,000,000 people; yet, we can still find the muskrat, mink, cottontail rabbit, water snake, field mice, nesting and feeding mallards and Canadian geese, an occasional deer, carp, catfish, suckers, sunfish, minnows, crayfish, frogs and bird life migrating through the area. It's an example of mother nature valiantly fighting for her domain in the midst of the inevitable human encroachment. The only real change that has taken place since early in the Colorado pioneering endeavors is the quality of creek's waters. They are now very heavily polluted with seepage from numerous gasoline stations located by the creek.

Aims/Goals

A. I am hoping to initiate a program study based on the ecology of this creek that will be carried on for many years.

B. First, we will make a general survey of this area by taking pictures and identifying existing fauna and flora.

C. We will sample water for its present condition.

D. We will determine sources of pollutants.

E. Students will be involved in an ACTION NOW campaign, especially after they have determined the source(s) of pollutants.

F. We will try to incorporate civic and environmental organizations into our overall planning. So far, The Wilderness Society, Audubon and the Rotarians have pledged assistance. Working through The Wilderness Society, we have been given a go-ahead by the Denver City Park Commission.

G. To sample existing fish life, I have ordered seines for this fall with a promise from the Colorado Game, Fish and Parks to help us if we need their assistance.

H. In cooperation with Audubon, I have promised to begin a year-round bird count. There is a possibility that we will plant bird cover and food shrubs.

I. We will set up an elementary weather station.

J. Stream flow studies could be handled by the sixth grade.

K. We will initiate an environmental newspaper published and edited by the middle schoolers on their Cherry Creek study, have drives for beer cans and newspapers, poster contests, essays, poems, caricature sketches, copies of letters sent to VIP'S by their colleagues, all of which could be done in their English classes or in Science.

L. From the middle school set up a committee that would be available to present findings and data to other schools, civic groups, environmental teach-ins, National Parks and school assemblies.

M. Rather than study a pond that is there, divert water into your own ponds where students can observe, study and record.

ENVIRONMENTAL STUDIES FOR GRADE 6

Darrel D. Dorsch

4

INTRODUCTION

The purpose of this unit is to study environmental degradation on the national, state and local levels, present facts as they now exist and, through actions on the part of the students, through school and home influence, to interest and activate actions to curb the problems we face in our natural environment.

A unit such as this has unlimited possibilities of absorption into the existing curriculum in all academic areas, including art and music.

I have considered two areas of study: classroom and field studies. Both areas may be modified according to local conditions, or either area may be used separately.

The main concept of this unit is: "Man and his technological advances, with a disregard to the consequences of his environment, has placed his environment in a near critical and incorrectable state."

I have four objectives for this unit: (1) to have my students see the beauty and ugliness of their environment, (2) to make my students aware of the environmental problems as they exist on the national and local levels, (3) to have my students think critically and objectively about solutions to the problems they will face in the future to correct past mistakes and (4) to interest them in action towards the solutions to the problems.

This unit is divided into the following study areas, which can be expanded or modified: wildlife, air pollution, water pollution, soil pollution, mineral resources and forest resources.

Included in "field studies" is a list of activities which may be used as a basis for action by the students.

A. WILDLIFE

Index:
Fair.

Trend:
Not very hopeful. The continued jump in human population inevitably will elbow aside more and more of our wildlife through the loss of habitat.

Concept:
Most wildlife populations are healthy but some 40 species of birds and mammals have been lost in the U. S. in the last 150 years and 102 species are endangered because of diminishing habitat.

1. Classroom Activities
   (a) The study of extinction. What is extinction?
       (1) natural
       (2) unnatural
   (b) What does it matter?
   (c) What is the cause?
   (d) What is being done by:
       (1) sportsmen
       (2) organizations
   (e) What else needs to be done?
   (f) What species are endangered?
       (1) mammals
       (2) birds
       (3) reptiles and amphibians
       (4) fishes
       (5) species in other lands

2. Field Activities
   (a) How can you help?
       (1) Become better informed on the problem by learning what state and federal governmental agencies are doing. Find out how and why wildlife habitat is being destroyed, and how this can be stopped.
       (2) Find out what forms of environmental pollution are being allowed and why.
       (3) Inform your state and federal officials of your concern and desire to correct the problem. Insist that complete protection be given to endangered species and their natural habitat.
       (4) Find out what commercial items are made from endangered animals. Do not purchase these items; explain the reason to merchants and ask them to stop selling them.
       (5) Let others know about the problem and ask them to help.
       (6) Join with organizations in the fight to protect endangered wildlife and to provide a healthy environment for man.
       (7) Support programs to set aside areas suitable for wilderness and wildlife refuges, parks and monuments, seashores, lakeshores, recreation areas, wild rivers and scenic trails.
       (8) Beautify the school grounds and conserve its natural resources by fence plantings of trees and shrubs, wildlife cover plantings, check dams, etc.
       (9) Construct and maintain bird feeding stations that will attract birds to where the children can observe them.
       (10) Develop habitat for birds and animals through planting food-bearing plants on school property and near-by approved areas.
       (11) Develop a nature trail, bird refuge, or nature area on land near the school; sloping land, gullies or small canyons may be used.
       (12) Learn proper methods of fishing and learn about and practice woods and hunter safety.
       (13) Arrange for displays in store windows to bring the problems to the attention of the public.
       (14) Write to the following offices for more information on rare and endangered animals:

Bureau of Sport Fisheries and Wildlife
U. S. Department of the Interior
Washington, D.C. 20240

World Wildlife Fund
Suite 728, 910 17th St., N.W.
Washington, D.C. 20006

Montana Department of Fish and Game
Mitchell Building
Helena, Montana 59601

National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036

3. Understanding
   (a) Some people are not only concerned about the extinction of a creature for its own sake, but alarmed about what such a catastrophe shows of man's attitude toward his own natural position. To alter the environment to the point of eliminating any kind of animal shows arrogance that is dangerous for man himself. For only through understanding the natural environment and adjusting within it can man insure his own existence and well-being. Scientific research is only beginning to uncover some of the complex relationships of all living things, including man. It is becoming painfully apparent that we cannot exclude ourselves and our activities from the total environmental picture. For us to be the unconcerned agent of the extinction of other creatures is to be irresponsible to our own species.

B. AIR POLLUTION

Index:
Very bad.

Trend:
We are losing.

Concept:
Air pollution is probably the most serious threat to our environment. It is a silent killer which hovers over every city in our nation and even touches the creatures of the polar life zones. It is no longer exclusively in the big cities.

1. Classroom Activities
   (a) The study of air pollution.
      (1) Natural pollution.
         a. sand and dust storms
         b. volcanic eruptions
         c. salty ocean spray
         d. forest fires
         e. the rotting of plants and animal remains produces great quantities of gases
         f. bacteria, molds and spores are borne aloft
         g. wind-blown pollen grains
      (2) Unnatural air pollution
         a. smoke from man-made fires
         b. smokestacks of factories add particles and gases to the atmosphere
         c. gases emitted from the exhaust pipes of automobiles

d. radioactive fallout from atomic-bomb blasts
e. space heating adds to pollution
f. refuse disposal adds to air pollution
g. power plants add to pollution

(3) What is being put into our atmosphere by these polluters?
(4) What health problems are they causing?
(5) What are state and federal governmental agencies doing about this problem?

2. Field Activities
(a) What can you do?
(1) Investigate how our state and local governments are attacking problems relating to air pollution.
(2) Arrange for displays in store windows to bring the problems to the attention of the public.
(3) Take photographs of the polluters; arrange a display and discussion for an assembly.
(4) Make charts, showing the amount of pollution put back into our air annually by the unnatural pollutants.
(5) Check with the local monitoring station to check the amount of pollution in the air in your local area.

3. Understanding
(a) Air pollution is the more serious kind of pollution since once in the atmosphere man is helpless and must rely on nature to purify it. (And that means washing it down to our land, where it goes into our rivers and on to the sea.) As long as we are so short-sighted as to use the atmosphere as a garbage dump, our air will become dirtier and more dangerous.

C. WATER POLLUTION

Index:
Bad.

Trend:
We're still losing.

Concept:
Virtually every stream, river, lake and estuary in the country is polluted to some degree and is becoming uglier and more dangerous.

1. Classroom Activities
(a) The study of water pollution.
(1) Natural pollutents
a. dissolved materials (solutes) from the gradual weathering of soil and rocks through which water passes
b. from biological reactions in soil and water
c. suspended matter (sediment) from erosion
(2) Unnatural pollutants
a. municipal wastes and industrial effluent
b. pesticides and fertilizer runoff from agricultural operations
c. heat released through cooling operations
d. radiation from atomic generating plants
e. chemical disposal from military uses

(b) Study the Water Quality Act of 1965, the Clean Water Restoration Act of 1966 and other recent legislation. Is our state complying with this federal legislation?

2. Field Activities
   (a) Find out what our state and local governments are doing to prevent or abate water pollution, both from municipalities and industries.
   (b) Arrange for displays in store windows to bring problems to the attention of the public.
   (c) Clean up a local creek or section of a local river bank and encourage others to do the same.
   (d) Study local sewage disposal practices. Is it primary, secondary, or tertiary treatment?

3. Understanding
   (a) Pollutants in our waters can be measured but we have too few monitoring devices. The effect each has on the health of humans and other forms of life is still largely unknown.

   (b) Although the water quality picture is gloomy, we have made some progress. Best legislative efforts are the Federal Water Pollution Control legislation which requires every state to establish its own water quality standards -- or have the federal government do it. The biggest problem is money!

D. OUR SOIL

Index:
Fair.

Trend:
We're losing ground slowly but steadily.

Concept:
Erosion toll is high, but a greater loss may be land gobbled up by roads, airports and cities.

1. Classroom Activities
   (a) The study of our soil
      (1) effects of erosion and how to prevent it
      (2) soil as a habitat of animals and plants
      (3) plant absorption and use of soil nutrients
      (4) fertility of soil and how to increase it naturally
      (5) organisms in the soil
      (6) water of the soil -- water-holding capacity and variations
      (7) the formation of the soil
      (8) types of soil
      (9) conservation practices
      (10) relation of minerals to soil
   (b) Soil pollution
      (1) fertilizers
      (2) pesticides
      (3) herbicides

2. Field Activities
   (a) What can we do?
      (1) assist in replanting burned over or eroded areas with trees, grasses, or other cover plants.

(2) carry out anti-litter projects: make trash bags for cars, make posters, use good practices.
(3) participate (or organize) in campaigns to clean up steams and highway rights-of-way.
(4) arrange for displays in store windows to bring the problems to the attention of the public.
(5) test soils for acidity and alkalinity.
(6) make biotic counts of soil diggings.

3. Understanding

(a) Our rich soil with its fruits and wildlife has nourished this nation through its difficult infancy, and again through its reckless and wastful adolesence. Now that we are a mature nation, we must realize that as we destroy the soil through misuse and pollution, we undercut the foundation of all living things.

(b) Land has many values in addition to food production. Every day airports, highways and suburban development voraciously gobble up hundreds of acres of land -- lost forever as green space, wildlife habitat and recreation areas.

B I B L I O G R A P H Y

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PLANTS: AN INTRODUCTION THROUGH ORGANIC GARDENING

5

Jean Ellen Belangie

This cell is designed to provide a working experience with plants. It can be applied to any age level, but it is being utilized at present on the primary level. It is an extremely flexible plan and can be adjusted to meet the needs of student, land and availability of money. The main purpose is to convey a basic understanding of plants and gardening principles. The hope is that by understanding, students will appreciate the environment and gardening. They will discover alternatives to insecticides, herbicides and artificial fertilizers.

Objectives:

1. Encourage respect for plants and their environments.
2. Introduce the basic ideas of conservation.
3. Provide a practical laboratory for studying the growth of plants, types of plants and their environments.
4. Introduce common flowers, herbs and vegetables as a source of food and pleasure.
5. Give practical experience in planting and caring for a garden.

Time:

The cell should cover about 18 weeks, divided into 3 equal periods in the fall, winter and spring. The time limit for each activity depends on the activity and the class. It would be advisable to spend one or two afternoons a week on preparing and planting the soil, rather than 40-minute periods every day.

The summer portion of this program is very important for both the garden and the students. As a result, this unit should be a community project. Help can be enlisted from local garden clubs, 4-H, FFA, a high school ecology club, the Grange and P.T.A. If none of these organizations are available or interested, ask service organizations or other clubs if they are willing to help.

Materials:

1. Land - a plot 25' by 50' would be ideal. However, if the school does not have any available space that is usable, there are other alternatives.
   a. borders around the school building
   b. parking areas that need planting
   c. an area in a park

   Remember that the soil can be improved by composting, bringing in additional topsoil, and persuading the school board that the corner of the school yard isn't used and should be converted into a garden.

2. Spades, hoes, forks and rakes with short handles so the young students can handle them. The handles should be painted a bright distinctive color to avoid loss.
3. Fencing, stakes, hoses, sprinklers, black plastic.
4. Wide assortment and variety of seeds, bulbs and cuttings - check local florist for reject cuttings.
5. Compost materials, including bonemeal, bloodmeal, rock powders and manure.

6. Peat pots, clay pots, watering can, terrarium and aquarium materials.
7. Material for a scarecrow (what's a garden without one!).
8. Simple films and books on plants, one of the recommended guides for teachers (see bibliography).
9. Primary size microscopes.
10. A cooperative custodian, principal and school board and willing teachers.

Fall

Introduce the students to the idea of a garden. The class will plan, prepare and plant the garden.

I. Planning

- A. Introduce the idea of a garden to the students.
  1. Discuss what they want to grow.
- B. Introduce bulbs and seeds to the students and have them decide on specific plants to grow - flowers, herbs, vegetables.
- C. Plan the garden
  1. Make a chart of the garden.
     - a. Place names and pictures of plants where they are to be planted for identification in the spring.
     - b. Principles of planning
       - (1) Utilize color and design
       - (2) Be mindful of needs of the plants
       - (3) Let the students do the planting

II. Preparing

- A. Introduce equipment and show the students how to properly use it and care for it.
- B. Measure garden area and set up area for compost pile.
- C. Prepare the compost pile and the ground for planting.
- D. Mark off specific areas to be planted.
- E. Erect fences if necessary to protect the garden from dogs or playing children. The fences can also be utilized for climbing plants.

III. Planting

- A. Plant flowers, herbs or vegetables which require fall planting. Follow the chart.
- B. Cover plants in the garden with leaves and mulch to prepare garden for the winter.

Winter

The winter section has two major purposes: to understand what the garden does while it is growing and to gain time for related and supplementary ideas.

I. Garden Activities

- A. Make a miniature compost pile in a gallon jar, so the students can observe the changes in it.
- B. Examine different types of seeds under microscopes, split the seeds open and draw pictures of them.
- C. Plant flowers, herbs and vegetables for transplanting in the spring.

II. Related Activities

A. Plant two different types of seeds, see how they differ as they grow.
B. Plant a number of bean plants and check for the following effects:
   1. too much water or not enough water
   2. the effects of different types of light or no light
   3. the effects of different soils and fertilizers
   4. the children should report on and record the effects on the plants at 2-, 4- and 6-week periods. A daily record should be kept.
C. Examine the parts of a plant, using a large plant with blossoms.
D. Plant some radishes in water and watch the roots form.
E. Place celery in ink or colored water and have the students observe the color move up the stalk. Also try it with a carnation.
F. Have students examine different types of seeds, leaves and fruit.
G. Plant herbs for Christmas presents.

Spring

In the spring the planting is completed. Students learn about general garden care.

I. Planting

A. Remove mulch from plants and turn under the soil.
B. Add compost where necessary.
C. Plant seeds, bulbs and plants started in the classroom after the danger of frost is passed.

II. General Garden Care

A. Demonstrate to the students
   1. weeding
   2. proper ways to water
   3. training plants to climb
   4. removing harmful insects from plants
B. Introduce alternatives to pesticides
   1. Beneficial Insects
      a. ladybugs
      b. praying mantis - these have to be ordered but they can survive after the last frosts and they die in the fall.
   2. Beneficial reptiles and birds
      a. provide nesting areas or shelters
      b. provide auxiliary feeding areas
      c. suggested reptiles are turtles, toads, or lizards
      d. suggested birds are any birds that feed on insects.
   3. Beneficial plants (the odor or juice of some plants has an insecticide quality about them.
      a. coriander - spider mites and aphids
      b. tansy - ants
      c. marigolds and other members of the aster family - slugs
      d. garlic juice - controls bacteria and fungus
   4. Keep the area clean. Place any excess organic matter in the compost pile.

Summer

This is when the need for community support is vital. The garden needs additional care during the summer. The students can weed and water, but they need supervision. By enlisting the aid of a garden club or service organization, the work can be supervized by a number of adults rather than just a few teachers. The actual working out of the details of summer care of the garden must be left up to the individual school and the community. However, the students must be included because it is their garden and their learning experience.

Supplementary Activities

I. Uses for the Garden

- A. Plan a dinner after the garden is harvested in the fall. Invite all the classes who built the garden, the adults who cared for it in the summer and the incoming first grade class, if the project is a primary grade project.
- B. Enter flowers and vegetables in a fair.
- C. Flowers could be fixed into bouquets and distributed to hospitals, rest homes, police stations, library, etc. Let the students make the bouquets, using recycled jars and cans that have been painted or decorated by the students.
- D. Dry flowers for bouquets or pictures.
- E. Harvest the seeds for the next garden.
- F. Sell excess vegetables as a class project for money.

II. Other Activities

- A. Study other environments
  - 1. Build terrariums
    - a. desert
    - b. woodland (see field trips)
    - c. pond and salt water aquariums
- B. Find references in literature to the plants in the garden.
- C. Read myths and legends related to the garden plants.

III. Field Trips

- A. Florist shop and Nursery - in late February, March or April take the class to a nursery and florist shop to find out how the professional gardeners raise and sell flowers.
- B. Woodland Environment - plan three trips to one wooded location; each trip should occur at a different season during the year - fall, winter and late spring.
  - 1. Have students collect samples of rocks, soil, plants and insects; each child should have a sack and box for collecting.
  - 2. Collect materials for terrarium.
  - 3. Take pictures of slides of the location to help the students recall previous trips.
  - 4. Set traps for observing small animals. These traps should be set the night before and should not hurt the animal but only trap him.
  - 5. Have students collect, press and identify plants.
  - 6. If the class collects seeds, plant them.
  - 7. Bring back some abandoned birds' nests and have the students plant them to see if the seeds contained in the nest will grow.

Bibliography

Starred books are excellent, and I would recommend that at least one be purchased as a manual for teachers. This is a brief bibliography but it provides a basis. I have included the catalogs because they provide excellent sources for materials which have been tried and that are free or inexpensive.

* Darlington, Jeanie, Grow Your Own, Bookworks, (Berkeley, Calif., 1970) $1.75 Paperback.

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* Rodale, Robert, The Basic Book of Organic Gardening, Ballantine (New York) 1971 $1.25 Paperback.

Magazines or Catalogues

The Big Rock Candy Mountain Catalogue, Portola Institute, Menlo Park, Calif. Two main issues a year and four supplements.

Organic Gardening and Farming Magazine, Rodale Press; Emmaus, Penna.

The Whole Earth Catalogue, Portola Institute, Menlo Park, Calif. The only two worthwhile issues are Fall 1969 and Fall 1970.

Resource People

County Extension Agent

Montana Federation of Garden Clubs or local garden clubs

Local florists and nursery owners

U. S. Department of Agriculture or a local representative such as the county extension agent.

ANIMALS IN THE CLASSROOM

Terry Lynn Boyer

6

The Living Classroom

The classroom environment should be interesting and exciting for the teacher and students--even for visiting parents. Most children have an interest in living things, and should have an opportunity to enjoy them in their classrooms.

Various plants can be grown in the classrooms and in the school's organic garden so that children and teachers can observe the life processes of flowering, seed formation and dormancy. It also offers the opportunity of relating a plant's life support system, energy sources and nutrient requirements to animal requirements. Since plants are comparably easy to maintain, little information is required for their incorporation into a "living" classroom.

However, the proper care and selection of animals in a classroom is more difficult. Therefore, the following information is provided in this guide to assist students and teachers in the selection and care of animals in their living classroom.

Amphibia

Habitat: Since amphibia, as the name implies, live a sort of double life, their distribution is varied. They are well known to all. We look in ponds, creeks, or swamps for frogs and tadpoles. In damp places under stones or in pools and brooks are small salamanders. Mud puppies or water dogs (salamanders) are more frequently found in creeks and rivers, while the toads live on dry land and may be seen in gardens, yards, or woods. The tree toads, as their name suggests, are most commonly found in trees where they so closely resemble the bark that they are seen with difficulty even when their call tells of their presence.

The frogs and salamanders have smooth, wet skins due to the secretion of mucous from glands in the skin, and they cannot live long without moisture. The toads have dry, horny skin which resists evaporation, hence they live in places often well removed from bodies of water or streams. They need only an occasional wetting which serves as a "drink." Toads, however, lay eggs in water, and their young are tadpoles similar to those of the frog.

Collecting: There is not much to learn about collecting amphibia. Catches are usually carried out with a long-handled hand net. Frogs may be caught more easily at night by directing a flashlight beam on them. They apparently are unable to escape, and sit quietly while the hunter approaches. (This method of hunting is sometimes prohibited by law.) They may be quickly seized or a small net may be placed over them. Salamanders found in small pools can be caught by hand or in a net or sieve. Those under stones and logs are caught by hand or in jars. Mud puppies and water dogs usually are not seen unless caught on a hook while fishing. They may bite the captor and should be handled with care. Contrary to popular opinion, the salamanders in the northern United States are not poisonous.

Culturing: Adult frogs are not completely aquatic and should not be forced to stay in water. They will not survive in an aquarium unless stones are provided which protrude above the water. The best arrangement is a cage or box with a large

flat pan of water at one end. The frog dries out rapidly and will die from lack of water in 1 to 3 days. Sand on the bottom of the cage prevents a rough surface from injuring the frog's legs as it hops about. The same arrangement is very satisfactory for toads. Salamanders vary from aquatic forms with external gills on the neck to terrestrial forms which will drown if kept in water. A box or aquarium of damp sand and a few large flat stones for the salamanders to hide under is a good habitat for land forms. Newts, the small aquatic salamanders, can be kept in an aquarium like goldfish. Any of these amphibia may be fed an occasional earthworm or live insect. Frogs will also eat small crawfish.

Reptiles

Habitat: Reptiles are not so limited in their distribution as fish and amphibia because most of them are independent of water. Turtles, lizards and snakes are found everywhere; alligators and crocodiles live only in southern streams.

Snakes attract more attention and excite more interest than any other type of animal. This is partly due to the age-old misconceptions that have been almost universally taught. It is the duty of the teacher to dispel as far as possible a negative attitude toward snakes and to emphasize the facts that most snakes are harmless and that many are decidedly beneficial; that most snakes fear man and do not go about ready to pounce upon him. In regions where rattlesnakes, copperheads and other poisonous forms are likely to be met, it would be advisable to have preserved or stuffed specimens so that students may learn to recognize them at sight.

Land turtles are not frequently found in most localities but can be purchased. They are easily kept alive by feeding them small pieces of meat and green vegetables and thus are highly desirable for school use. Small ornamental turtles may be purchased at pet shops or variety stories. They keep fairly well in aquaria. The larger aquatic forms which are found in ponds and streams are not so desirable because they require some care unless a large tank is available. All turtles need heat from a 100-watt light bulb 2-3 hours a day.

Lizards, such as the common little pine lizard and the so-called chameleon (Iguanidae) are readily kept in captivity. They can be captured in the woods, where it requires sharp eyes to detect them on the dull bark of tree trunks or among the green leaves. Their peculiarity in changing color so that they blend into their environment is well known and serves to make collecting difficult. They also may be purchased.

Collecting: Little need be said about methods of collecting reptiles. They must be located and captured individually. Snakes are best caught under a forked stick. This is an assurance against being bitten, unless the collector is certain of his species. A long stick with a fork at one end, is used and when a snake is found, the stick, fork down, is thrust over the snake's neck. This will hold it in a manner which prevents coiling and offers time to maneuver the captive into a box or can.

Culturing: Most reptiles are carnivorous and feed upon such small prey as worms, insects, small rodents like mice and shrews, birds, eggs, fish, frogs and sometimes they can be fed upon fresh meat such as beef or liver cut into small pieces. Turtles must not be kept in aquaria with fish or other aquatic animals because turtles are likely to kill or injure them. Lizards and snakes should be kept in small cages, preferably with sand bottom and a piece of branching tree. They usually can be fed insects such as meal worms and beetles.

Ant Colony

Making an ant colony. Students may prepare a temporary observation ant colony for class use. Partially fill a battery jar or large box with slightly moistened sandy soil. Collect an ant hill from the field and place it in the container. Include in the colony some workers and a queen. Keep the container covered or in the dark. Galleries made by the ants may be visible through the glass sides of the container. When possible, place the jar in a basin of water so that a moat is formed, preventing the escape of ants.

Feed the ants lettuce, carrots and potatoes (to provide moisture as well as food) and on bread crumbs and diluted molasses or honey. Occasionally, add some dead insects. Remove all excess food to prevent the growth of molds.

Chickens

Watching chickens hatch in an incubator is an interesting experience for children. It is possible to secure one-egg electric incubators or large commercial incubators. However, the children can have the experience of making their own. The materials are simple and inexpensive.

Two cardboard cartons are required. One should be abcut 10" x 10" x 14", and the other, about 12" x 12" x 16", or enough larger to allow paper to be stuffed between the two boxes for insulation. You will also need a short lamp cord, socket and bulb, a wall thermometer, and a thermostat switch (such as the Formaster Automatic Temperature Control, Model 594.405, approximate cost $3.) Obtain one large cake pan, about 8" x 10" and a piece of 1/4" or 1/2" wire mesh about 12" x 14", or big enough to fit the floor of the box with enough overlap to fold under and make a platform for holding the eggs suspended above the water in the cake pan. Cut one end from the small box. Then cut a large square window in a side of the large box which will fit against the open end of the inner box.

Cut a hole in the top of the smaller box and suspend a light bulb with a clothespin. Above the light anchor a piece of asbestos paper. Be sure one wire to the light bulb goes through the thermostat.

Fit a large pane of glass over the window aperture. Tape all the edges for safety. Use a double thickness of 1 1/2-inch to 2-inch adhesive to make a flap along the top edge. Staple to box to form a hinge so you can open the window at will. Paint the inner surface of the cake (water) pan to inhibit rusting. Bend the wire to fit above it and fit into bottom of smaller box.

Fasten the thermometer and thermostat to inner wall of inside box. Line box with kitchen foil to reflect heat toward eggs. Pack space between boxes with crumpled newspaper or other insulation. Try different sizes of light bulbs until you have one that keeps the box close to 103° F all the time. It will help to make three or four 3/4-inch to 1-inch holes to be plugged with corks. Those can be removed or inserted to regulate the heat level.

The class will have an opportunity to gain more than one concept of science through such an experiment, e.g., heat reflection and radiation, differential heating (thermostat principle), insulation and electric circuits. Thus, the experience provides many overlapping learnings in addition to what they learn about reproduction and the life cycle of a chicken.

Once an even 103°F temperature can be maintained you are ready to secure a dozen fertile eggs. The chicken farmer may show the children how he "candles"

these to determine fertility, or the children may wish to recheck with some very simple safe equipment, e.g., a light bulb shielded inside a small tin can with a small hole aperture to it.

At the end of three days remove one egg and crack it just enough to slip contents into shallow dish. The heart beat should be discernible in a 3-day embryo. You may want to make a pencil mark on the eggs as a record, repeat every three days to let children observe the development. The eggs should be turned daily and water kept in the pan underneath the wire platform to maintain viable humidity. Hen's eggs take 21 days to hatch. Once the chicks have hatched, wait a day and then reduce the incubator temperature a few degrees each day to room temperature. The incubator can serve as their home until they are three weeks old. To allow them to go in and out of their home at will, cut out one wall of their box 2 inches above the floor. Cover this opening with cloth thumbtacked to the carton. Outside make a 12-inch high fence of wire mesh or screening. A sheet of lightweight metal under the incubator and runway may be quickly removed and hosed off. Baby chick mesh can be purchased at a feed store that also sells food and water dishes.

It should be noted that chick starter is supplied usually without any supplementary grain or anything else. By the time the chicks are six to eight weeks old, a considerable amount of grain is being fed. There are some protective foods such as milk, whether skimmed milk, whole milk, buttermilk, or skimmed-milk powder, also liver meal and green feeds. When these are provided, they tend to overcome any deficiencies that may possibly exist in the diet. The birds will relish an occasional bit of lettuce, fresh lawn clippings, cabbage, or other green feeds.

The amount of feed the birds will need at different ages varies considerably according to the efficiency of the feed containers and the amount wasted, but the following figures may be a guide. Up to six weeks of age they will eat just slightly over two pounds of feed per bird each month. Males will eat slightly more and chickens of the heavier breeds will eat still more. Adult birds will eat about seven pounds of food per month.

An important point is to make sure not only that the feed is in the containers, but also that these are readily accessible to the birds and that there is ample feeding space. For day-old chicks, one should provide at least one inch of feeding space per chick. When water is first given it should be in containers right on the floor of the cage so that the chicks can dip down to get it. At about three weeks of age the fountain may safely be put on two-inch blocks or even higher to reduce contamination.

The first supply of mash may be given on flat boards or in shallow hoppers.

Chrysalids and Cocoons

Whether bought from a dealer or found outdoors, chrysalids and cocoons must be properly cared for in the classroom. The problem is to keep them from getting so dry from indoor heat that the moths or butterflies die or emerge imperfect or misshapen. Try putting them into a terrarium or into a quart jar with sod on the bottom. Cover with wire screen or netting. The sod must be kept moist. In both cases, as in nature, the cocoon or chrysalis should not lie directly on the moist earth. It will mold. It is best to suspend it in mid-air from a thread or twig.

As soon as the inhabitant shows signs of emerging, remove it to a quart container large enough for it to spread its wings to dry. A twig to rest upon will help. When the insect is all out, add a dab of cotton soaked in sugar water.

Watch to see if the insect unrolls its long tongue to feed.

Craw Fish (Crayfish) Water-Fleas, and Sow-bugs - Pill Bugs

These are among the most widespread anthropods which are not insects. They make excellent material for class use.

Habitat: All of these forms may be found in water. The isopods and crayfish are ordinarily situated under stones in streams. The crayfish usually live where the water is not very swfft and the isopods cling to the undersurface of rocks where the water moves freely, as in rapids. Crayfish may be found in water surrounding reeds and cel grass as well. Land isopods, such as pill-bugs, are frequently found under boards in damp places. The water-fleas are more frequently found in very quiet lagoons of streams, in ponds and even very small pools.

Collecting: For collecting crayfish the flat sided dip-net is convenient when the animals are not concealed under large rocks. When they are under the rocks, the collecting becomes a matter of capturing each individual separately. This may be done by hand or with a very small short-handled net. Lift the stone with much care, and, since the crayfish swims swiftly backwards, place the net in such a position as to cause the crayfish to swim into it. A can or bucket that has a perforated lid is a convenient container for returning them alive to the school.

Isopods are easy to collect as they adhere to the rocks and may be removed with forceps. The land forms may be picked up with the fingers.

Water-fleas are sometimes so numerous that they can be obtained by dipping the water containing them. They can be concentrated by dipping with a very small hand net or tea strainer.

Culturing: Any of the aquatic forms may be kept alive indefinitely in aquaria. Running water and plenty of water plants are a distinct advantage. Temperatures around 60 to 70°F are best. Crayfish will eat worms or small pieces of meat but should be removed and fed in a separate pan of water to avoid polluting the aquarium. When kept in the same water with fish or tadpoles the crayfish will often try to capture them and sometimes succeed. At least they tear the fins with their claws. Water-fleas should be cultured in a separate vessel, in water to which has been added a little boiled bone meal, sheep manure, or pulverized boiled egg (2 oz. of dry material per gallon of water). Bacteria thrive in such a solution and the water-fleas live on the bacteria. Land sow-bugs may be cultured in a jar containing moist soil and rotting pieces of wood.

Crickets

Let the children find out by trial and error what crickets like to eat. If the children can catch a pair or more of crickets, place them in a flower pot lamp chimney cage. Keep, if possible, on a sunny window sill and keep the sod moist but not soggy. If the food, shelter, and temperature are to their liking, the patent-leather fiddlers may delight the children by chirping during a lull. Make rough blackboard sketches of the detail of a male cricket's file and scraper. Female crickets are identified by the long ovipositor.

Keeping crickets in the classroom may lead the children to look for and bring in examples of other famous insect "noise makers" - the katydid, the cicada and the tiny but loud-voiced tree cricket.

This is how to set up a cricket cage. Plant a plug of fresh grass or clover in a small flower pot. Set over this and imbed firmly in the soil a glass lamp chimney or a roll of heavy cellophane or fine wire mesh. Lamp chimneys are usually available from hardware stores; heavy cellophane is safer but more easily tipped over; wire mesh affords less visibility. Cover the top with cheesecloth. If you have tree crickets, place inside the chimney a twig on which they can climb.

Daphnia

These small laterally compressed water fleas may be collected from ponds, lakes or streams. They are characterized by a body enclosed in a transparent bivalve shell. A cleft marks off the head from the rest of the body. Large second antennae are modified as swimming appendages to assist the four to six pairs of swimming legs. During the spring and summer, females are usually found. Eggs generally develop parthenogenetically at these times. In the autumn, males appear and the "winter eggs" are fertilized. Female daphnia may be recognized by the curved shape of the end of the intestine. In the male the intestine is a straight tube.

A great many successful methods have been described for maintaining daphnia, using the fact that water fleas feed upon bacteria and nonfilamentous algae. Three methods which have proved successful are described below.

Using Green Water: Fill large battery jars with tap water and let them stand over night to permit evaporation of gases which may be harmful. Then put the battery jars in strong sunlight and innoculate them with nonfilamentous algae from a "soupy green" aquarium. After this "green water" has been standing for two to three days, add daphnia and several milliliters of hard-boiled egg yolk mashed into a paste with a bit of culture medium. You may also add a suspension of yeast to stimulate growth. This method produces a luxuriant growth of daphnia. The temperature range may vary between 24° and 26°C (75° and 79°F.). The sediment often contains viable eggs.

Using a Modification of Knop's Solution: In this method, a 6 percent stock solution is prepared. For immediate use, add five liters of distilled water to one liter of the stock solution. This will yield a dilute 0.1 percent solution. When needed, this may be further diluted with an additional four liters of distilled water. Even this weak solution will maintain daphnia adequately when the culture medium has been innoculated with nonfilamentous algae and allowed to stand in light until the water becomes tinged with a green color. About once a week, add a bit of hard-boiled egg yolk paste and a bit of yeast suspension.

Modified Knop's Solution: Combine the following materials with one liter of distilled water and pour into several battery jars: 1 g of KNO_3, 1 g of $MgSO_4$, and finally 1 g K_2HPO_4. Then add 3 g of calcium nitrate, $Ca(NO_3)_2$. As a result, a precipitate of calcium phosphate, $Ca_3(PO_4)_2$, is formed.

Using a Culture of Bacteria: A rich growth of Bacillus Coli is used as the food source. First, filter pond water through coarse filter paper. Then add about 90 g of garden soil and 17 g of cottonseed meal to one liter of this filtered pond water. Stir the mixture well and set it aside at room temperature for five days. Fermentation takes place and gases are formed. After the five days have elapsed, pour off the supernatant fluid and strain through muslin. An almost pure culture of bacilus coli is produced. Correct the pH (or use pH meter if available).

Now dilute this fluid with pond water (1 part of strained fluid to 100 parts of pond water). Innoculate this culture medium with daphnia. Keep the cultures

in large battery jars. Each week prepare a small amount of the old culture each time a new medium is established. In this way innoculation with the original kind of bacteria is achieved.

Uses in the Classroom: Daphnia serve as excellent food for small fish, tadpoles and hydras.

Introduce a drop of a culture of these water fleas on a slide containing one or two hydras. Under a microscope watch ingestion. What is the role of the nematocysts?

Use daphnia to clear an aquarium that has become soupy green.

Demonstrate the rapidly beating heart of daphnia under a low-power microscope. You may want to demonstrate the effect of narcotic drugs on the heartbeat as well. Use a hanging-drop preparation, or put bits of broken coverslips near the daphnia as you prepare a wet mount to avoid crushing the animals.

Small amounts of adrenalin and pituitrin cause a spontaneous shedding of the eggs from the dorsal brood sac.

Use wet mounts of daphnia to study circulation, respiratory system and peristalsis.

In some lake-dwelling daphnia, students may study the change in head shape -- from round to helmet shape-- that occurs between spring and summer. What conditions cause this cyclomorphosis?

Diving Beetles

These are scavengers and may be kept upon prepared goldfish foods.

Dragon Fly

Dragon-fly nymphs can be kept in small amounts of water and will feed freely. Small worms, insects with soft bodies and pieces of earthworm may be used as food. When the food is held in front of the nymph with a pair of forceps, it will seize the food. This is an interesting sight for students and illustrates the feeding activities of these voracious insects. If reared in this manner the shedding of the skeleton and emergence of the adult also may be observed. Do not place dragon-fly nymphs in aquaria with other insects, worms, tadpoles, or very small fish because the dragon-fly nymphs may eat them.

Earthworms

The children can dig up earthworms from the school garden or collect them from the ground surface after a heavy rain. Earthworms are interesting and valuable to keep in the classroom. If need be, they also serve as winter food for frogs, toads, snakes and turtles in the classroom. Moisten some dark soil (loam or leaf mold) and some light-colored soil (sand). Make three layers of soil in each jar (two wide-mouth pickle or mayonnaise jars) - light, dark, or vice versa. Put the earthworms on top of the soil of one jar. Wrap the jar with a sheet of dark or black paper, which should act to lure the worms to tunnel at the periphery of the jar where they can be seen, rather than to bury themselves in the center. In a few days you should begin to see dark tunnels through the sand layer until eventually

the soil in the jar is quite thoroughly mixed.

Compare the mixing with that of the jar without worms. Earthworms, by bringing up subsoil and taking down topsoil, contribute inestimably to soil fertility and hence to human welfare. Watch the soil pass through earthworms as they tunnel through it. They have no teeth but a remarkable gizzard which grinds and pulverizes the soil they take into their systems. Observe how they pull bits of leaves into their mouths with their upper lips. Where tunnels against the glass permit watching the earthworm in its hole, note how it holds onto the top of the hole with the tip of the tail and moves in a circle searching for food. When not observing the earthworms, be sure to replace the black covering around the jar.

Soon you will notice worm castings of digested purverized soil on top of the soil in your jar.

At commercial worm farms, worms are fed such succulent soft diet as olive pits and walnut shells! Anglers who keep a supply of worms on hand feed them a mixture of coffee grounds and cornmeal, in small doses.

Uses in the Classroom: Earthworms are excellent organisms to use in studies of taxis. When the cover is removed so that the animals are exposed to light, watch the rapid burrowing movements. Earthworms may also be used to study chemotaxis.

Earthworms are also favorable material for dissection. The reproductive, digestive, and circulatory systems, as well as the ventral nerve cord, may be studied as the worm is dissected. Of course, earthworms may also be cultivated as food for frogs and some reptiles maintained in the laboratory. Mature worms are also a source of living gametes and the nematode Rhabditis may be found in the nephridia.

Fish

Habitat: Since almost any permanent creek, river, pond, or lake contains fish, and even many brooks with pools which do not dry up contain fish of some kind, it is possible to find them and to capture them with a seine or trap. If seining or trapping is prohibited it is usually possible to get special permission for educational purposes. The variety stores, bait stores and pet shops all have goldfish, minnows, guppies and other varieties that keep readily in captivity. A study of nesting habits and breeding places of fish or of the kinds of situations where different species are found is very instructive and interesting.

Collecting: Fish caught on the conventional hook are often damaged too severely to be satisfactory for an aquarium but would do quite well to preserve. It is much better to use a net or trap. Small hand nets can be used for minnows in pools or small streams. By using a small trap in a brook or narrow part of a stream the minnows can be driven into it. In larger bodies of water a lift net is successful for minnows and may be set and baited by placing bread crumbs on the water over the net. When the minnows are feeding, lift the net quickly. Fish for laboratory use may be obtained at fish markets at relatively low cost and preserved in formalin or used fresh. Small fish for aquaria or bowls are available at pet shops, bait stores and variety stores. Familiarize yourself with your fish and game laws before seining or trapping game fish. Very large minnows or small bait fish may be purchased from a bait store already preserved.

Culturing: Most states have literature on fish hatcheries and fish culturing which is done for commercial stocking. Anyone can rear goldfish, guppies, etc., in a bowl or aquarium. Have plenty of water plants and feed very little. If water plants are not used it is necessary to feed prepared fish food and to change the water frequently to prevent fouling. If plants are used and little or no prepared food is added it is unnecessary to change the water. Keep the aquarium out of direct sunlight but near enough to a window for the plants to do well. A north window is best if one is available. The addition of a few water snails helps keep down pollution and retards the growth of algae on the sides of the aquarium although the algae do no harm other than to impede vision.

Preserving: Fish are best preserved in formalin. If very many are placed in a jar or can it is best to leave them in a 5 percent solution for about a week and then transfer them to a fresh 5 or 6 percent solution. This is true for bulky animals of any kind as they greatly dilute the preservative and may spoil. Be sure to slit the ventral body wall in order to let the preservative into the cavity. If this is not done there may be some decomposition before the formalin penetrates to the internal organs. The addition of 15 percent glycerin to the formalin prevents the fish from becoming very stiff.

Frogs and Toads

The development of a dark spot in a mass of frog eggs into a tadpole and then into the adult frog is one of the perennial wonders of spring. Early in the spring, borrow or buy "Voices of the Night," a Cornell University recording of amphibian voices. Without comment, play it for the children and elicit their explanation. The ensuing discussion should bring out some interesting questions. This might be the day to bring in some amphibian eggs. Children may be requested the day before to bring in enough pond water and green scum in which to float the eggs and later feed the newborn. Toad and salamander eggs are laid in strings of jelly which frog eggs come in masses of jelly. The jelly serves as the tadpole's first food when it emerges from the egg. Later it feeds on green scum or algae.

Cover the glass container in which you are keeping the eggs. This will reduce evaporation and keep out foreign matter such as chalk dust which may be toxic to them. It is by far best to use distilled water available in most communities from a local bottling firm. If necessary to add tap water, be sure to let it stand several days. This is to permit chlorine to dissipate. Keep in a relatively cool place with some sunlight, but not enough to overheat the water. Normal room temperature without much variation should keep the water about the right hatching temperature.

From egg to frog usually takes about three months, though this varies from species to species. Some species, as, for example, bull frogs, require two years to mature. Watching the legs appear is always interesting. Do both emerge at the same time?

The adult amphibian will feel comfortable in a moist woodland terrarium. If a child finds a spring peeper or treetoad, he will enjoy watching how it can scale the vertical walls of a class container or terrarium. Perhaps when the room is quiet, it will even feel comfortable enough to "peep." Thin rocks built into a miniature "grotto" or formed into rough wall in one end of a terrarium or aquarium furnish a cool area which is most desirable to frogs and toads.

Perhaps you can train your frog or toad to eat an insect or bit of hamburger or earthworm dangled and moving in front of it. Children will enjoy and be astonished to see the speed with which the tongue, fastened in front of the mouth,

flicks out and gathers in the offering.

Fruit Fly

With all of man's skill in developing pesticides, the insects are still with us, and in huge numbers. To illustrate the sheer force of insect multiplication, grow a hatch of fruit flies. Usually all this takes is a pair of pint jars with covers and some very ripe bananas and/or grapes. Cover the jars and set in a warm room (not sunlight) until fruit flies begin to develop from the ripe fruit. Some use corn meal boiled five minutes in addition to the fruit. Keep a record of the number of flies in each bottle every day for a week. You will probably note an increase. Depending on their facility with numbers, the children may be able to estimate the rate of increase and project it for a month or a year. The figures tell the story. If insects multiplied unchecked, this would soon be a world of insects.

Another method of raising fruit flies illustrates the complete life cycle. Cut off the top of a cone-shaped paper cup to make a funnel for a jar. Put some overripe bananas or other fruit in the jar. As soon as a half dozen fruit flies have hatched from the fruit or entered from outside and been trapped, cover the jar or plug with cotton. Among this half dozen there should be some fruit flies of both sexes. The females are larger and have a slightly broader abdomen with small lines across the end. Males can be distinguished by a black-tipped abdomen. You may need a magnifying glass to make sex differentiation.

The eggs may already be in the fruit or laid by the visitors. In a day or two the larvae should emerge and feed about a week before pupation. They can be seen better if a bit of crumpled paper or rag is dropped into the jar. They will crawl out on this to pupate. In about five days the pupae change to adults and mate soon after they emerge. You now have two generations of fruit flies - the ones you caught and those you raised. Grandchildren can be raised as quickly by preparing another habitat jar. For closer observation place fruit flies in stoppered test tubes wrapped in foil. The flies will move into the part that is open to the light.

Gerbils

Gerbils are small animals that are remarkably curious, but not cuddly. They are brown and have delicate whiskers. Gerbils are often found in deserts.

Gerbils need something to bed down in. Things to use could be paper towels, cedar chips, colored paper, paper napkins, old clothes and cardboard boxes. They shred paper and cardboard quite readily so do not worry about that. They are always rearranging their homes.

Every two or three weeks is often enough to clean their house because the desert gerbils are such dry animals that they have little smelliness to them. When you clean, do a good job with an old cloth and lots of water. Vinyl contact paper (with a sticky back) makes easy-to-clean floors for cages.

At first begin with an escape proof cage such as an old fish tank with a screen top, or a small animal cage from a pet store. Homemade cages can be kept in a bath tub the first day or two. Even if the gerbils get out of the cage, they will not be lost because the tub will fence them in.

Playgrounds: Dirt or paper shreds are snug shelter for gerbils, but they need exciting places to explore, like jungle gyms or cardboard boxes held together with sticky tape and ladders of all sorts. Some of the best play equipment for gerbils is made of thin plastic or of cardboard, because they gnaw it apart. Gerbils need to gnaw for they, like rabbits and mice, have front teeth which never stop growing and the gnawing wears the teeth away like filing your fingernails.

What Gerbils Eat: Gerbils are not fussy eaters. They thrive on a regular diet of birdseed. They often eat sunflower seeds in it first. They will even eat corn flakes and other grains. On the high dry plains of their homeland, gerbils live on plants, eating roots, seeds, and green parts. For a while they will enjoy a special food - but then they will tire of it and be ready for something else. Offer yours a variety of things once in a while to see what they will accept.

Gerbils do not overeat, so you can always leave enough of their seed food with them to last many days.

Most animals must have quite a lot of water, but a gerbil drinks at most a few drops a day, due to his coming from the desert. He is content with no drinking at all if you will provide a little crisp greens - lettuce, celery, carrots every day or two.

If you must leave your gerbils for several days, they may be better off with some water to use if they need it. A small watering bottle (animal) from a pet store is a drinking fountain gerbils can manage. Give your gerbils a few days to practice before you leave them.

Goldfish

Goldfish eggs hatch in 3 to 6 days, at 60° to 70° F. The very young should be placed in tanks with no more than six inches of water. They require protozoa, small daphnia, brineshrimp, naupelli, and fine, dust-like powdered fish food. As goldfish reach six weeks of age, an increasing amount of various cereals may be fed to them. For this purpose strained oatmeal is recommended as part of the diet, but it should not be used exclusively. As fishes increase in size, the kind of food prepared in stores in the little boxes is recommended. Goldfish utilize minute particles of food in the water, and in the process goldfish ingest water.

When maintained in cold water, 60°-70°F, and not crowded, the goldfish is extremely hardy.

Guinea Pigs

Food: Guinea pigs differ from other rodents and from mammals in general in requiring a relatively large amount of vitamin C. This is furnished in fresh green foods such as alfalfa, clover and blue grass. The Vitamin C also is found in cabbage, lettuce, carrot tops and sprouted oats. Cabbages should be fed sparingly at first; otherwise, some of the animals may go off feed and die. Sprouted oats are generally fed during the winter months. Both the tops and the roots of sprouted oats are good for the guinea pig. However, since they do not take this feed readily, it is advisable to feed a guinea pig with other green feed for about two weeks. Young animals especially may be unwilling to eat and may die of scurvy.

Guinea pigs require a relatively large amount of roughage in their food. It is therefore advantageous to keep them in supply of hay moistened with water to prevent the feed from being dusty.

A basic ground oat green mixture should be fed to the guinea pig (available at a local variety store or pet shop).

It is advisable to keep drinking water available to the animals at all times.

Guinea pigs never eat very much at a time, but they eat often. Therefore, it pays to keep food before them most of the time, or about 20 out of every 24 hours. If possible, it is desirable to have the feed dishes empty in the morning. The morning feed should be enough to last the animal all day, and in the late afternoon only enough should be added to keep the animal going most of the night. If there is feed left in the dish in the morning, the morning feed should be light in order to insure it being eaten by evening. Keeping the feed dish full all of the time is about as objectionable as keeping it empty most of the time. There is no record in regard to the weight of feed given each animal. One learns by experience.

Cages: All-metal cages with wire-mesh bottoms are suggested, with the entire floor made up of 1/2 inch mesh. The big advantage in this type of floor is that only in very rare cases do the feces fail to pass through. All-metal cages with snug-fitting doors prevent mice from entering. Guinea pigs pay no attention to mice but the latter, if given a chance, will befoul the feed making it unpalatable to the guinea pigs.

The feed dishes are also metal and are hung on the door of each cage to make it more convenient to put feed into them.

Characteristics: Unlike other rodents such as rats and mice, guinea pigs are unable to climb. Because of their short, small legs and comparatively heavy bodies, they find it difficult to jump. Therefore, it is possible to keep them in pens with fences only about two feet high, without danger of their escaping. Similarly. they can be safely carried in open-top wire baskets about 18 inches high.

They are generally timid in their relations with man. The very timid ones will make desperate attempts to free themselves when held, and as a result one's hands may be scratched. A few in desperation may even bite if they are given the opportunity. The less timid ones were and will be relatively docile if they are held correctly.

The males especially are not timid in their relations with each other. Females usually do not fight each other, but there are exceptions.

If a cage contains several females they will usually resent a new arrival if it is also a female. One method of keeping peace is to saturate the belly and back of the new arrival with a coal tar disinfectant. The smell acts as a repellent. The treatment also should be effective in preventing the spread of disease. Similarly, if a female is placed in a cage containing a male and another female, the latter will resent the intrusion. The coal-tar method is effective also in this case. Another advantage is that it delays and calms down the attentions of an overzealous male.

Guinea pigs are noisier than other laboratory rodents. They squeal when they think they are to be fed. They are very sensitive to sound and hear the

slightest rustle of green alfalfa, etc. If they are very noisy at feeding time, and especially at other times, it is usually a sign that they either are being underfed or have an inadequate ration.

Guppies

If you are a beginner in aquariums, the best fish to learn on are guppies. They are cheap, hardy and breed almost too easily. Unlike most fish, guppies are born alive, the eggs hatching inside the female's body. The male may eat them unless he is put in another tank. Males are smaller than females, with a spot on the tail.

Guppies require a little more than a moderate even temperature (60°-70°F), whereas for most other tropical fish a heater and thermostat are needed to keep the water at constant temperature. Since most schools have a master switch which shuts off all electric current after school, the heater alone will not obviate dead fish in the morning. Heating equipment for aquariums is available from pet shops or from larger mail order houses. If you plan to keep tropical fish, it is wise to confer with your local pet shop.

When you buy guppies, get a small amount of food at the same time. You may also wish to invest in a snail to deep down algae and remove dead material. One snail per gallon is recommended. Your pet store dealer will also help you decide if you want to buy washed sand for the bottom, or wash your own and bake it in the oven to kill mold. He will also advise you to invest in a few sprigs of such common aquarium plants as sagittaria, elodea, vallisneria, cabomba, or muriophyllum. The first three are particularly valuable as sources of oxygen for your fish. Above all, the dealer will help you decide how many plants you will need to balance the number of fish in your tank. The fish, of couse, give off the carbon dioxide which plants use in making food.

Hamsters

Purchasing Your Pet Hamster: The signs of good health are readily apparent, soft silken fur, plump body, a general feeling of solidity to the body, and prominent bright eyes. Lightboned animals are light in weight and of flimsy body structure (an inherited characteristic). Pimple on the ears, nose, feet, or belly may be indicative of many a contagious disease for which there is no known cure.

To some extent the age of the hamster can be determined by examination of the hairs inside the ears: white hairs in young animals; naked, shiny ears indicate animals past their prime. Also, very young animals are the color of house mice, with the first mature coat appearing at 12 weeks. It is generally best to buy one hamster at a time, for two may fight. Sexes should be kept separate until breeding is desired, therefore, two different cages should be provided if a pair is to be maintained. For apparent reasons, it is unwise to buy your pet hamster from cages containing mixed sexes. For an only pet males or unbred females are satisfactory.

Nicked ears, except for appearance sake, are acceptable, for the nicks are merely breeders marks, used to identify individuals for breeding records.

How to Handle Your Pet Hamster: Hamsters are naturally gentle, trusting and inquisitive, but they must be handled often to keep them tame. Young

ones especially have need for security and trust in their keeper. Hamsters are liable to bite when frightened and apparently they are more likely to bite when they are in their own domains (their cages) than when in an area over which they do not feel possessive.

The proper way to tame a hamster is to let the animal out of its cage in a restricted area, such as a table top, and feed it some special tidbit. Without any intent to pick the animal up, gently stroke its back. Daily repetition of this act will get it used to your touch. Pick the animal up and slowly approach from above, letting the hamster see your hand, and gently close about it, cradling its entire body. Teasing, chasing or other distracting or frightening actions will destroy the animal's confidence in you. Always grab it firmly (not tightly) and securely. Once you have picked it up, offer it something to eat. Repetition of this act will condition the hamster to handling and give it complete security in you. When you associate training with feeding, the training becomes easier.

Hamsters will usually wash themselves, cat fashion after being handled.

How to Maintain Your Pet Hamster: The requirements of hamsters are not great: an adequate cage, litter and nesting material, water and food, exercise, toys and space and proper temperature and humidity. Small cages will suffice, about one foot square for a single pet. A bird cage is fine with little alteration (a shelf rather than perches and suitable water). A simple and very satisfactory homemade pen can be of heavy wood at least 1/2" thick and for ventiliation, one end and the top of hardware cloth (wire mesh), 1/2" for adults and 1/4" for babies, with tight joints and openings which can be closed securely. A removable top is especially desirable as it facilitates cleaning and eliminates the likelihood of the animal being injured when the top is replaced, (or falling out when it is removed). It should be made heavy enough to prevent the hamster from dislodging it and escaping. It is recommended to fasten the wire mesh on the inside to prevent gnawing on exposed corners and subsequent destruction of the pen. All-metal cages, such as can be purchased in your pet shop, are more suitable.

Cleaning Your Hamster: A thorough weekly cleaning is desirable. Remove all hoarded food, change the litter material and wash the cage with hot soapy water and a stiff brush.

Hamsters are clean animals and, except for the very young ones, will deposit their waste in one spot, usually a corner of the cage. All hamsters confined in the same cage will use the same corner. Thus, it is easy to occasionally remove the soiled litter with an instrument such as a pancake turner. In a partial cleaning, it is well to remember that hamsters do not like their nests or hoards disturbed, and the more frequently they are, the less happy the hamsters will be.

The Hamster's Nest: A wide range of materials are available for litter and nesting purposes: shredded paper, wood wool (excelsior), soft hay, soft absorbent wood shavings, sawdust, ground corn cobs, cane, peanut shells, dry grass, pine needles, or any clean, absorbent materials which provide free ventilation. A bed depth of a half inch is considered satisfactory.

Water for the Hamster: The more preferable means of providing water is the water bottle with about a four-ounce capacity, with a copper or glass tube of 1/4" to 1/16" diameter extending from its stopper and having a 45° to 60° bend. The water bottle, available at pet shops, should be fastened inverted to the side or on the top of the cage.

If for some reason this system is undesirable, use a watering dish. It should not rust, easily tip or spill. When it is greater that 1 1/2 inches deep, a wire mesh ladder for young hamsters to climb out if they fall in should be provided.

Feeding: Hamsters are 'round-the-clock nibblers, being slow, leisurely eaters and seldom eating food when it is given to them (unless it is a particularly tasty item). Since they are creatures of habit, they should be fed at the same time every other day, preferably in the evening when they eat their main meal.

Your hamster should be fed a varied diet, consisting of various kinds of grains, greens and grubs, with supplements of fruits, vegetables, meats, nuts, etc. Actually, almost anything can be given with no fear of overeating. Since the greatest percentage of a hamster's moisture requirement is obtained from green vegetables, these should always be in sufficient supply, especially in the warmer months. Pelleted food, which is readily eaten, ought to be moistened, particularly if youngsters are present. Your pet shop sells packaged hamster food.

In more detail, these items are what hamsters will eat and enjoy:

Vegetables: All kinds and especially the greens, including turnip and carrot tops.

Fruits: Most kinds (there is some doubt about the use of fruits, with some breeders recommending them and others advising against their use).

Grains: All common kinds

Nuts: All kinds with or without shells. Also sunflower seeds and soy beans.

Dog Biscuits and Pellet Food of any Kind: They should contain more than 20 percent protein.

Cooked Meats: Again, an item of controversy.

Milk: Pasteurized or condensed (never raw), especially valuable for expecting and nursing mothers and for the young.

Hamsters should be fed somewhat in excess of their daily needs to satisfy the desire to hoard, with suitable caution regarding perishable foods. This hoard should not be disturbed too often.

Meal Worms

The immediate value of meal worms is to provide a ready and acceptable live food supply, especially during winter, for pet reptiles or amphibians that hibernate briefly in a warm classroom. Their partial metamorphosis from larval to adult (beetle) form will contribute to the child's understanding of the life cycle of various creatures. Meal worms are usually available at pet or feed stores. Secure a small quantity and put them in a quart or half-gallon glass jar partly filled with wheat bran, bran flakes, and/or cornmeal. For variety you might occasionally add a bread crust or small chunk of apple or carrot. Punch air holes in the jar's tin cover or cover with cloth or netting. Keep in a warm, dark place. For faster multiplication divide the supply into two containers, one to be left undisturbed for breeding, one to be used for pet food.

Mice

It is extremely important to maintain a colony of mice by themselves and not in contact with any other species of animals. No new animals should be brought into the room from any outside source. Epidemics frequently occur as a result of the introduction of foreign mice.

Mice do well at any reasonable temperature of 70° to 80°F. The temperature at which mice are kept depends upon the type of cage they are kept in. If wooden boxes with open-wire-mesh covers are used, the temperature of the room may be kept lower than when an open-wire-mesh or solid metal cage is used. The humidity should be kept between 50 and 60 percent although this is very difficult to control.

Cage: Perhaps the best box for keeping mice is a wooden one with an open-wire-mesh cover. The boxes are made of 1/2 inch planed knot-free white pine measuring 6 by 12 inches and 6 by 11 inches. The cut lumber can be obtained from any lumber yard. When assembled, the box with an open top consists of two equal compartments or cages. They should be painted with two coats of paint not containing lead or any other material that may be detrimental to the health of the animal. One coat should be a good interior flat paint; the second coat a gloss supreme. Or, perhaps you would choose to dip the boxes into either shellac or varnish or a combination of the two. Insert a small opening in the cover for a wire hopper in which pelleted mouse food is placed. Lay the water bottle on top of the cover.

Insert a bent glass drinking tube, commonly referred to as a "gooseneck," into the water bottle and hold in place with a suitably bored rubber stopper. The flow of water is controlled by a narrowing of the end of the gooseneck which is inserted through the top cover of the mouse box. The tip of the drinking tube in the mouse box should be near the hopper so that the mice have access to the water while they are eating pelleted food through the opening the mesh hopper. If properly adjusted, there should be no dripping on the bottom of the cage unless the bottle is jiggled.

Cleaning the Cages: Boxes in which breeding mice are kept should be changed once a week, while boxes containing adult mice should be changed twice a week. As mice grow older they soil the boxes more, and consequently their boxes should be changed more frequently. Boxes can be scraped with a rubber spatula and soaked briefly in warm water to which has been added a small amount of cresote or some other standard disinfecting solution. The boxes are then lightly scrubbed with lukewarm water and piled upside down for at least 24 hours, or until dry.

Clean sawdust of wood shavings (kiln dried) are then placed in each box to the depth of approximately a half inch. A small amount of cotton batting is placed upon the sawdust.

Some people prefer to use solid metal cages which can be sterilized thoroughly by steam with or without pressure. One difficulty of keeping mice in solid metal cages is that they do not raise their young well unless the temperature of the room is kept considerably higher than when wooden boxes are used. Another disadvantage of solid metal is that the acid urine of mice will corrode the metal and thus produce holes through the bottom of the box. Properly handled, a wooden box has a longer life span than a solid metal one.

Diet: The diet for mice: Murishmix (a product of the Pratt Food Company, Philadelphia, Pa.,) is placed in the hopper twice a week. A supplement of a mixture of wheat, oats, sunflower seeds and calf-meal pellets is given to the mice in a small handful at least once a week. Mice in the breeding colony also receive a small piece (quarter slice) of enriched bread, soaked in fortified milk to which has been added medicinal cod-liver oil (10cc. to a quart). The sliced bread is quartered one day and kept overnight. The quart of milk is shaken and partly poured over the bread. Periodically fresh lettuce thoroughly washed in cold running water is given to the mice. However, the use of lettuce is usually unnecessary. Under this regime there is little likelihood of a dietary deficiency.

Planaria

Look for these small flatworms on the underside of submerged logs and under stones in ponds and lakes. Several varieties may be found in clear running water, but the usual forms are the small, blackish planaria maculato and the more frequent laboratory form, the brown Dugesia tigrina. When you find some in a submerged log, wrap the whole log in wet newspaper and bring it into the laboratory. Submerge the log in a white enamel pan of water and peel off sections of wood. Usually the planaria float to the top. Planarians may also be baited by submerging a piece of raw beef liver or hardboiled egg yolk (tied in cheesecloth) attached to a string in a cold stream or lake. This method often attracts the larger form, planaria-dorotocephalia. Brush off the gathered forms into collecting jars and submerge your bait in another part of the lake or stream.

Transfer the collected plant materials into larger glass jars and keep them in moderate light. Soon planaria may be found clustering on the surface of the water or adhering to the sides of the jars. Then pick them off with a pipette and isolate them in separate culture containers.

Because planaria are photonegative, they should be maintained in black or opaque containers; enameled pans or enameled cans are excellent. Change the water frequently, with fresh additions of aquarium water, spring water, or Bandwein's Solution A. Keep them at a temperature about 18°C (65°F). Once a week feed the planarians finely chopped raw beef liver; better still, since live food does not foul the water, feed bits of worms. At other times, feed them bits of hardboiled egg yolk. Remove the excess food with a pipette after several hours to avoid fouling the water.

Uses in the Classroom: Planaria represent the platyhelminthes. These flatworms are classic material for studies in regeneration. At times you may find planaria reproducing by fragmentation. They rarely reproduce sexually in the laboratory; orange cocoons occasionally hatch 4 to 6 small planaria in about 2 weeks.

Use planaria to show taxis. What happens when one is put on a slide and the glass is tapped? How do they respond to light?

For examination under the microscope, you may find it necessary to narcotize the animals before putting them on a slide. To a small watch glass or Syracuse dish of pond water containing a few planaria, add a small amount of chloretone or a few crystals of epsom salts or menthol. When the forms are quiet, lift with a toothpick and arrange the animals on slides so that the probasces is uppermost.

Rabbits

A tame rabbit may be permitted the freedom of the classroom. This is good for both rabbit and children. Rabbits need exercise and children need to get used to animals. However, do not keep wild rabbits as pets because they sometimes carry the disease tularemia. In a mild climate or in spring and fall, a rabbit can live in a cage on the outdoor window sill safe from dogs and cats. In the classroom, he needs a cardboard box shelter (which can be disposed of and replaced when sanitation demands) where he may retreat and rest. Cut one end from the box for an entrance way. For overnight and weekends the 2' or 3' square mesh cage is adequate though it is cramped for a full-grown rabbit over more extended periods. It is of utmost importance with rabbits, or with any animals

in the classroom to have equipment which is easily and quickly cleaned by the children with a minimum of the teacher's help. Rabbits will need heavy non-tippable containers for food and water. One can build a rack or manger for green food from wire screening. This should be attached low and to one side of the cage. All animals choose one spot in a cage or room for excretion. Once this selected place is known spread newspaper and change it frequently. A dirty pen, damp food and poor ventilation may soon produce a sick rabbit. In such a case, take the animal immediately to a veterinarian. Never lift rabbits by their long, sensitive ears. Pick them up by the loose shoulder skin, supporting the hind quarters with a gloved hand or cloth protected hand as a guard against long hind claws.

Feeding: Rabbits normally are more active and eat more at night, especially during warm weather. Where grain and hay are both fed, a good practice is to feed the grain the first thing in the morning (what the rabbits will consume in about 1/2 hour) and hay at night. When complete pelleted rations are used, it is probably best to feed late in the afternoon. Adult animals which are not being bred are best hand fed in this manner. To keep adult rabbits healthy they should never be fed quite all they will eat and should always be impatient for the feed at feeding time. The average adult rabbit will consume 2 to 4 oz. of grain daily, depending on size. Young growing stock in which most rapid development is desired should have both grain and hay at all times.

Particular attention should be paid to the condition of the feed and water receptacles at every feeding. Water crocks or bottles that have become contaminated by fecal materials, hay or grain, should be replaced before new feed is supplied and the old container should be thoroughly washed, scalded, or otherwise disinfected. Rabbits should have an abundant supply of water available at all times.

Salamanders

Preparing Vivaria: Long, low vivaria covered with glass are most desirable for salamanders. However, whatever type of container is used, it should provide a pool with a "beach" for most kinds of salamanders.

The vivarium must be cleaned as thoroughly as if it were to house fish. At one end of the tank put a small glass dish or noncorrosive metal pan to serve as a pool. Cover the rest of the tank with coarse pebbles together with a few pieces of charcoal. This cover placed over the pebbles with a loamage - soil rich in humus, slanting the layers of soil away from the small pool to a height of 3 inches and keeping about 2 inches of water in the pool. Students can prepare an effective natural habitat by planting a "beach" around the pool, using layers of moss, such as Spagnum, Mnium, Dicranum or similar types. Place at least one rock in the water. Try planting the rest of the vivarium with small ferns, partridge berries and a variety of other mosses that have different textures and shades of green.

Feeding: Almost all salamanders require living food such as daphnia, tubifers, etc. On occasion, some forms such as triturus (the red eft) may take fresh liver if it is dangled in front of them on a string. But dead animals and food that has not been eaten must be removed within an hour or so to avoid fouling the tank.

Temperature: The best temperature range lies between 15° and 18°C (59° and 64°F). However, many salamanders can survive at temperatures as high as 25°C (77°F).

Snails and Clams

Habitat: Snails and clams of several kinds can be found in most creeks and ponds, while oysters may be obtained at markets in cities. In some places land snails are abundant. People living near the seashore are familiar with a great variety of marine mollusks.

Clams are usually at least partly submerged in muck or sand and in the water, though sometimes they may be found in mud flats. Snails attach themselves to stones or to sticks and stems of growing plants. Land forms are commonly under stones, logs or in leaf mold on the ground. Sometimes they climb up on trees and shrubs.

Collecting: Usually mollusks will be collected along with numerous other animals or plants. The containers for mollusks alone may consist of jars with stoppers or screw caps. Something larger will be necessary for clams if large ones are captured or if very many are to be brought back alive. Snails are best gathered by hand. If returned alive they should be placed in some of the water from which they are taken or the soil or leaf mold in which they are found. A rake or pronged hoe with long tines is convenient to rake up clams from sand.

Culture of These Animals: After snails have been captured in the field, do not leave the lids of the containers closed any longer than is absolutely necessary. By no means allow the containers to stand in the sun. This is a very common error of the inexperienced collector and applies to all other forms collected alive. Most of the common snails found in ponds and streams will survive without further attention if placed in an ordinary aquarium. A deep pan or bucket of water with water plants in it is sufficient if a regular aquarium is not available. If numerous plants are present, no feeding is necessary. Land snails may be kept in dampened leaf mold or fed lettuce leaves. Most grocers or food markets will donate enough outer cast-off leaves.

Clams are not so easy to keep but sometimes survive for a long time in large aquaria well stocked with algae and other plants. It is best to have several inches of muck, sand or gravel on the bottom of the aquarium.

Interesting studies may be made upon mollusks, their reproduction, development of the snail, pattern and winding of shells and the composition and structure of shells and of the animals themselves.

Preserving: Snails may be killed by heating in water. If done slowly they often will protrude from their shells. They also may be dropped directly into 6 to 8 percent formalin. Clams should have the edge of the shell broken and a peg driven between the valves to allow the formalin to penetrate thoroughly. The breaking of the edge may be done by pounding with a hammer or stone.

Spiders

Spiders are especially well known to everyone and their habits are interesting for study.

Habitat: Spiders are almost as widespread as insects, but not so varied in their adaptations. They may be found wherever food is available. Much interest centers around their web-weaving activities. They live in trees, on plants, in the ground and under stones. Some spiders seldom build webs but stalk

their prey. The web weaving is sometimes restricted to spinning cocoons or nests for eggs. For interesting details see "The Spider Book," by Comstock.

Collecting: Orb collection is both fascinating and instructive. Get some sheets of black-surfaced cardboard and cut it into different-sized rectangles. These cards can be carried along when the orbs are to be collected. When an orb has been located, prepare a card by painting the edge of it with shellac. For this purpose a small bottle and camel's hair brush is needed. If the card is then pressed gently against the web, the radiating strands will adhere to the edges of the card. As soon as it has sufficiently dried, the web may be cut loose from its original moorings and carried away. These cards may be framed under glass or cellophane wrapped to protect them. If an atomizer is carried along and filled with a solution of very thin shellac and whiting, the orb may be sprayed before being fastened to the card. Such sprayed webs are more easily seen on the black background. Small wood framework may be constructed and the webs attached in the same manner, letting the orb swing free instead of stretched over the black card. In either case the spider which made the web may be collected, and after it has dried and been spread so that the legs are in a natural position, it may be attached to the orb to enhance the demonstration. If notes on the location and habits of the spiders are taken as collected they may be attached or filed and the project becomes very instructive.

To collect the spiders take along small vials or bottles of 85 percent alcohol and an appropriate pair of forceps. Drop the spider directly into the alcohol. It may however, be placed in an insect killing bottle and dried for mounting. Very large spiders with abdomens full of soft material become shriveled upon drying. This may be avoided by slitting the ventral wall, scraping out the contents and stuffing with cotton.

Culturing: Some spiders can be kept in captivity for years. They should be placed in large jars with cloth covers instead of caps or in small screen cages. Some enclosures, such as flies, meal worms or moths can be added every few days as food. If a small pad of cheesecloth or cotton is suspended from the cloth cover and moistened regularly it will provide sufficient moisture. Under such conditions of captivity they sometimes lay eggs and hatch young provided the female has already been fertilized or you have both sexes.

Preserving: If spiders are collected and killed by dropping them into 85 percent alcohol solution they may be tightly stoppered and kept for any length of time. As suggested above, they also may be killed in the same manner as insects and placed in mounts, either Riker mounts or in cardboard of cellophane mounts.

THE FOLLOWING MATERIALS ARE AVAILABLE FOR THE ASKING - CHECK CATALOGS FOR ADDRESSES

"Care and Feeding of Laboratory Animals" - Ralston Purina

Carolina Tips - Carolina

Living Specimens in the School Laboratory
(General Biological)

Turtox Ness: Turtox Service Leaflets (Set of some 60 leaflets), General Biological

World's Bulletin, leaflets on techniques, World's

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THE WIND CANNOT READ -- BUT YOU CAN!

7

Mavoureen Greseth and Sukumar Nayar

A Look at the Possibility of Integrating
Environmental Education into a
Junior-Senior High Language-Arts Program

Five Ways to Kill a Man

There are many cumbersome ways to kill a man: you can make him carry a plank of wood to the top of a hill and nail him to it. To do this properly you require a crowd of people wearing sandals, a cock that crows, a cloak to dissect, a sponge, some vinegar and one man to hammer the nails home.

Or you can take a length of steel, shaped and chased in a traditional way, and attempt to pierce the metal cage he wears. But for this you need white horses, English trees, men with bows and arrows, at least two flags, a prince and a castle to hold your banquet in.

Dispensing with nobility, you may, if the wind allows, blow gas at him. But then you need a mile of mud sliced through with ditches, not to mention black boots, bomb craters, more mud, a plague of rats, a dozen songs and some round hats made of steel.

In an age of airplanes, you may fly miles above your victim and dispose of him by pressing one small switch. All you then require is an ocean to separate you, two systems of government, a nation's scientists, several factories, a psychopath and land that no one needs for several years.

These are, as I began, cumbersome ways to kill a man. Simpler, direct and much more neat is to see that he is living somewhere in a city in the middle of the twentieth century, and leave him there.

Edwin Brock

PREFACE

The title for this cell was suggested by an old Chinese poem, which translates as follows:

Though the sign says
Do not pluck the flowers
It is useless against the wind
Which cannot read

But man can. Yet in spite of his education and sophistication it seems he is bent on ravaging his environment, which conservationist David Bower calls the "grand larceny against future." It seems the curse of modern man that he has to continually face new possibilities of self-destruction. After World War II, the nuclear weapons gave him the power to wipe out life from the face of the earth. The population increase has been so great that a disaster on a global scale is imminent. Now he is confronting another man-made danger -- the poisoning of his natural environment with chemicals, fumes, garbage, heat, noise, ugliness and urban overcrowding.

For every American the decay in his environment has become a personal experience -- a glass of water bitter with impurities, the mountain view obscured by haze, the acrid smell of industrial smoke or automobile exhaust, the boom of the jet or the rumble of the truck piercing the 85-decibel level beyond which noise can damage the ear. A few years ago, nobody was paying close enough attention to tell exactly when Lake Erie died. Acidic wastes from the surrounding factories have strained Lake Erie's water of virtually every form of life except sludgeworms and a mutant of the carp that has adjusted to living off poison. Louisiana's state bird, the pelican, has vanished from its shores (600 of the birds remain in an island off the California coast, but last year they produced only five chicks; the rest of their eggs collapsed with weakened shells that contained high concentrations of DDT.). Even mother's milk is unfit for consumption because it contains DDT to the extent of .10 to .30 parts per million. It is two to six times the amount allowed in milk for commercial sale.

Every year Americans junk seven million cars, 100 million tires, 20 million tons of water, 28 billion bottles and 48 billion cans. Every year U. S. manufacturing plants discard 165 million tons of solid waste and gush 172 billion tons of smoke and fumes into the air. Wild animals and birds are being ruthlessly exterminated and forests are being denuded. There is a chemical mass warfare being waged today indiscriminately against insects, weeds and fungi.

> "Who has made the decision that sets in motion these chains of poisonings, this ever-widening wave of death that spreads out like ripples when a pebble is dropped into a still pond? Who has placed in one pan of the scales the leaves that might have been eaten by the beetles and in the other the pitiful heaps of many hued feathers, the lifeless remains of the birds that fell before the unselective bludgeon of insecticidal poisons? Who has decided -- who has the right to decide -- for the countless legions of people who were not consulted that the supreme value is a world without insects, even though it be also a sterile world ungraced by the curving of a bird in flight. The decision is that of the authoritarian temporarily encrusted with power; he made it during a moment of inattention by millions to whom beauty and the ordered world of nature still have a meaning that is deep and imperative." -- Silent Spring by Rachel Carson

In order to rescue the environment man must learn to consider time in larger stretches. He will have to perceive disasters that do not occur with dramatic suddenness -- the tiny increments of waste that gradually overwhelm a river's powers of self-cleansing, for example; and he must grow accustomed to undertaking cures that will show no results until after his lifetime. The real spectre that pollution casts over man's future is not, perhaps, the extinction of Homo Sapiens but his mutation into some human equivalent of the carp now lurking in Lake Erie's fetid depths, living off poison.

This "operation rescue" has to start in the schools, because it is in the school that a sense of awareness of the environment around us, and a sense of responsibility to maintain the environment, can be inculcated. Beginning with an appreciation of the environment in the elementary grades, the teachers can, by projecting students into scenes showing a blanket of flowers, the freshness of a brook, the austere beauty of a majestic waterfall, attune the students to a natural world, which they will explore more intimately for themselves. At the junior and senior high level this intimacy, which would develop into the environmental awareness, should make the students ask the following questions: how do I fit in? what does it all mean to me? how do I affect it? where does it leave off and I begin? And as part of the environmental awareness education program, they would learn that (1) there is a web of life, and they are part of it, (2) this web is in trouble and (3) they can do something about it.

This cell is for the benefit of language arts teachers of the junior-senior high school. It tries to show how it is possible to inculcate environmental awareness incidentally through a regular language arts program.

The format of the cell is as follows.

A. Objectives of the Environmental Education Program
B. How Environmental Education can be Integrated into a Language Arts Program
C. List of Poems, Stories, Fiction and Non-fiction that is Relevant to the Program
D. Appendix

   (1) Suggestions for handling some of the resource materials
   (2) A copy of a model poster
   (3) Quotable quotes

E. Bibliography

Objectives of the Environmental Education Program

(1) A clear understanding that man is an inseparable part of a system consisting of man, his culture and the biophysical environment, and that man has the ability to alter the inter-relationships of this system.

(2) A broad understanding of the biophysical environment, both natural and manmade, and its role in contemporary society.

(3) A fundamental understanding of the biophysical environmental problems confronting man, how these problems can be solved, and the responsibility of citizens and government to work toward their solution.

(4) Attitudes of concern for the quality of the biophysical environment which will motivate citizens to participate in biophysical environmental

problem solving.

How Environmental Education Can Be Integrated Into a Language Arts Program

The basic function of language is to communicate ideas and feelings. The general objective of the language arts program is to provide experience in writing and in using the skills of speaking, listening and reading. The desired end is that students will be aware of and enthusiastic about their use of language in thinking and in conveying ideas clearly, accurately and fluently.

To these three basic objectives we have added one more, which tunes in with the whole concept of environmental education -- that is PERCEIVING. This is because environmental education anywhere seeks to create a concern for all environments that leads to a commitment to preserve or develop optimum environments and to improve less desirable environments. To achieve this, perception is very essential. At the elementary level, the students should be exposed to the brilliance and intricacy of the ecosystem. At this time only awareness is necessary; and this is achieved by perceiving.

Below is a list of some specific objectives particularly relevant to environmental education under the four general objectives mentioned. It is stressed that these specific objectives are meant to complement others that are commonly considered under the four major objectives. They are not all-inclusive.

1. PERCEIVING

a. To develop an awareness of self -- physically, emotionally, socially; to perceive oneself in relation to the ecosystem, a skein in the web of life.
b. To perceive the beauty of nature through the medium of poetry; to perceive such sensuous appeals as those emanating from color, design, artifacts, photography, painting, sculpture, music, dance, drama, poetry, stories, etc.
c. To develop sensitivity to the freedom concomitant with independence of thought; to be open to a variety of views before deciding what one accepts or rejects, to inculcate a sense of values.

2. LISTENING

a. To enjoy listening to sounds around us: songs of birds, children's voices, whirr of toys, tones of musical instruments, bells, sounds of animals, rustle of leaves, etc.
b. To become aware of how interesting words can be.
c. To react sensitively to prose and peotry; to develop aesthetic taste.
d. To be silent occasionally and to know when to be silent; to realize the values of listening rather than speaking.

3. SPEAKING

a. To express observations, experiences and feelings.
b. To question as a way of learning.
c. To express one's self or to express one's interpretations in play acting, story telling, poetry reading, ballad singing.

4. READING

a. To enjoy looking at pictures, and to interpret them.
b. To recognize the nature of meanings of what is read; to make of reading a

question asking, problem solving process; to realize that language suggests more than it says.

c. To read orally with evidence that one identifies with and understands the material, character motivation, emotional content, etc.
d. To value the literary tradition of one's culture; to be able to identify folklore and allusions.
e. To develop (i.e., appropriately change) one's beliefs, attitudes and concepts on the basis of rich and varied reading experiences.
f. To read habitually and to cherish reading -- to see its value as a leisure-time activity.

5. WRITING

a. To produce written signs and symbols with a sense of exploration and discovery.
b. To enjoy writing prose and verse; to enjoy writing various genres and modes (haiku verse, free verse, fables, stories, skits, advertisements, etc.).

Resource Materials Relevant to the Program

Given below is a list of poems, short stories, novels and other materials that can be easily used by the language arts teacher. These materials very conveniently serve as resources for environmental education as well. Though there are two lists -- junior high and senior high -- they are by no means exclusive.

Junior High School

TITLE	AUTHOR	SOURCE
Poems		
"Logs"	Walter de la Mare	Rhymes and Verses
"God's World"	Edna St. Vincent Millay	U. S. in Literature
"The Rhodora"	Ralph Waldo Emerson	"
"The Daffodils"	William Wordsworth	"
"The Fawn"	Edna St. Vincent Millay	"
"The Eagle"	Alfred Tennyson	"
"Daniel Boone"	Stephen Vincent Benet	"
"The Horses"	Edwin Muir	"
"Prayers from the Arc"	De Gasztold	Viking Press
"The Vagabond"	R. L. Stevenson	
Short Stories		
"The Endless Desert"	Sven Anders Hedin	Dimensions
"The Heart of a Hunter"	R. C. Ruark	Spectrum 2
"Lobo"	Ernest T. Seton	Prose and Poetry
"The Wild Goat's Kid"	Liam O'Flaherty	" "
Novels		
The White Panther	Theodore Waldeck	Viking Press
Gray-neck	D. Mukherji	E. P. Dutton Co.
The Polar Bear -- King of the Arctic	Sven A. Hedin	Dimensions
A Sand County Almanac	Aldo Leopold	Oxford Univ. Press
Silent Spring	Rachel Carson	Fawcett Book

Periodicals

Readers Digest
Newsweek
Time
National Wildlife
Audubon

Films and Filmstrips

"The Cry of the Marsh" -- Film
"Ill Winds on a Sunny Day" -- Film
"The Vanishing Prairie" -- Film
"The Living Desert" -- Film
"Say Goodbye" -- Film

Senior High School

TITLE	AUTHOR	SOURCE
Poems		
"To a Waterfowl"	William C. Bryant	U. S. in Literature
"The Rhodora"	Ralph W. Emerson	" "
"The Tide Rises, The Tide Falls"	Henry W. Longfellow	" "
"God's World"	Edna St. Vincent Millay	" "
"The Daffodils"	William Wordsworth	" "
"Birches"	Robert Frost	Prose and Poetry of America
"An Introduction to Haiku"	Harold Henderson	Doubleday
"Chicago"	Carl Sandburg	U. S. in Literature
"Inscription on Entering a Forest"	William C. Bryant	
"Daniel Boone"	Stephen Vincent Benet	
"Tuft of Flowers"	Robert Frost	
"The Windhover"	Gerald M. Hopkins	
"Imitations of Immortality"	William Wordsworth	
"Lines Composed a Few Miles Above Tintern Abbey"	William Wordsworth	
"The City of the End of Things"	A. Lampman	
"The Horses"	Edwin Muir	
"On the Companionship with Nature"	A. Lampman	
"The Eagle"	Alfred Tennyson	
"Five Ways to Kill a Man"	Edwin Brock	
Short Stories		
"The Crowd"	Ray Bradbury	October Country
"The Bear"	William Faulkner	

TITLE	AUTHOR	SOURCE
Novels and Plays		
An Enemy of the People	Henrik Ibsen	
When the Legends Die	H. Borland	
Non-fiction		
Cities -- A Reading Program		Holt, Rinehart & Winston
A Sand County Almanac	A. Leopold	Oxford
The Quiet Crisis	Stewart Udall	Discus Book
Silent Spring	Rachel Carson	Fawcett
Moment in the Sun	Rienow and Rienow	Ballantine Books
The Frail Ocean	Wesley Marx	" "
So Human an Animal	Rene Dubos	Scribner
The Population Bomb	Paul Ehrlich	Ballantine Books
Why I Went to the Wood	Henry David Thoreau	U. S. in Literature

Periodicals

Readers Digest
Time
Newsweek
National Wildlife
The Atlantic
Population Reference Bureau Bulletin

Films and Filmstrips

"The Cry of the Marsh" -- Film
"Ill Winds on a Sunny Day" -- Film
"The Vanishing Prairie" -- Film
"The Living Desert" -- Film
"Concord -- A Nation's Conscience" -- Filmstrip
Part I - Emerson
Part II - Thoreau
"Say Goodbye" -- Film

Suggestions as to How to Handle Some of the Resource Materials

Successful teaching of a resource unit depends on the teacher, the unit itself, the class and several other factors. These suggestions are not to be considered universal. One of the many ways of handling some of the units is explained below. These methods may or may not work in other situations.

One more point needs stressing. The method of approach, the follow-up exercises, etc., have a bias toward environmental education. For a language arts program not geared to this, the method of approach might need revision or reconsideration.

The main line of approach for follow-up exercises consists of panel discussions, group discussions, creative writing, designing posters, designing suitable dust jackets for books, individual reports, both oral and written, field trips for observation and enjoyment, making of films, etc.

A Unit on Cities

Senior High School Language Arts

(1) Discuss the poem "Chicago" by Carl Sandburg.

a) What ideas of the city is Sandburg emphasizing?
b) Cite images that help develop these ideas.
c) What is the tone of the poem?
d) When do you think was the poem written?
e) What differences would you see in the Chicago of today?

(2) Use Holt Rinehart's Impact Series "Cities."

(3) Read the play, "An Enemy of the People," by Ibsen.

Follow-up Exercises

(1) Prepare a travel brochure on "Chicago" for the benefit of tourists. Like all travel literature, it should contain only complimentary things.

(2) Get another section of the class to prepare a sequel to (1) above, stressing the seamy side of Chicago.

(3) Arrange a debate between these two groups.

(4) Have the students interview other teachers in the school and learn whether the school operates the same way as the metropolitan schools in New York.

(5) What is the major theme of Ibsen's play?

(6) Would a government put up with a questionable situation instead of alienating groups who have vested interests? Would the U. S. government legislate that lead be removed from the gasoline sold to motorists? Do you think Peter Stockman's action and attitude would find a parallel in modern history? Do you approve of his action?

(7) Prepare the report Dr. Stockman would have published in the "People's Messenger," if he had the chance.

(8) What effect does the press have on political problems?

(9) With the help of your science teachers list the possible impurities that would have been found in the mineral waters.

(10) With the help of your mathematics teacher, prepare graphs showing the increase in population, industries, cars, schools and hospitals, in your city or any city of your choice (Chicago, maybe) within the last 50 years.

(11) Compare urban and rural life. Which would you prefer? Why?

A Unit on "Wilderness"

Junior High Language Arts

Discuss the poem "Daniel Boone" by Stephen Vincent Benet.

What are the implications of "all lost wild America?"

In National Wildlife, June-July, 1968, read Sigurd Olson's article "All Lost Wild America," pp. 4-7, and discuss Benet's vision as part of our heritage.

a) What does the "Wilderness Act" mean to man?
b) Almost all America's wilderness was lost; only two and a half percent of our land mass remains. How can we secure it and possibly other areas for future generations?
c) What does wilderness have to offer modern man in our mobile and leisure world?
d) Read Walden, Vol. I by Thoreau, the passage beginning "I went to the woods because..."

A Unit on River Pollution

Junior High Language Arts

Ask the children to collect as many poems as possible on "rivers." Impress on them how the river has molded the life of communities, and how poets have been fascinated by the river as a natural phenomenon -- beautiful and inspiring.

Introduce "The Vagabond" by Robert Louis Stevenson. The class, after a total look at the poem and the poet's desire to identify with the environment, would look at the specific problem -- river pollution. The first stanza is relevant.

Give to me the life I love,
Let the lave go by me
Give the jolly heaven above
And the byway nigh me
Bed in the bush with stars to see,
Bread I dip in the river --
There's the life for a man like me,
There's the life for ever.

In how many rivers in the world would a modern-day poet dare dip his bread? Why? From now on the class can go into the details of river pollution and perhaps ways and means of improving the situation.

A Unit on Man and His Environment

Junior High Language Arts

Read the poem "Horses" by Edwin Muir.

After reading a powerful poem like "Horses" the students should be ready to discuss the impact of an atomic war on man and his environment.

a) To what war is Muir referring?

b) Discuss the demise of man-made things.

c) Discuss the implications of the phrase "we have gone back far past our father's land."

d) Discuss the role of the horse.

e) What must man do now in order to begin life anew?

Quotable Quotes

"Have we become a nation of people who would sell the sunset if someone would put a price on it?" -- Robert Rienow

"Man has lost the capacity to foresee and to forestall. He will end by destroying the earth." -- Schweitzer

"Are we perhaps fated to mark the ocean with ruin, to plunder, to pollute and contend until we have a ghost ocean bereft of all by the voice of the waves?" -- Wesley Marx

"The land was ours before we were the land's." -- Robert Frost

"Mankind shares a common habitat. We have mortagaged the old homestead, and nature is liable to foreclose." -- Lord Ritchie-Calder

"A level exists beyond which a nation devotes too much of its productive capacity to simply keeping its head above dirty water." -- Fred Suiger

Title Bibliography - Language Arts Unit

The purpose of this bibliography is to provide the teacher with a brief varied supplementary reading list. It has two sections grade school and junior-senior high books. Grade level is provided at the end of each listing. Subject area is provided when necessary. The best books are starred (*). If there is a companion movie it will also be indicated.

Children's Books K-6

Animal Poems, ed. William Cole (World) P - Adv.
Animal Worlds, Marston Bates (Random House, 1963) P-I
Animals in India, Ylla (Harper) I
Animals and Their Ways, J. D. Carthy (Doubleday) I
*The Balance of Nature, Louis & Margery Milne (Knopf, 1960) I
Bambi Felix Salton P-I
The Bears and I, Robert F. Leslie (Ballantine) I *Adv.
A Beaver's Story, E. Liers (Viking) I
The Biggest Bear, L. Ward - (Houghton-Mifflin) P-I
The Big Wave, Pearl Buck (Day) Adv.
Call It Courage, A. Sperry (Macmillan) I-Adv.
Chendru, A. Sucksdorf (Harcourt) I-Adv. India
Children of the Northlights, I & E d'Aulaire (Viking) P-I
Conservationists and What They Do, C. W. Harrison (Watts, 1963) Adv.

The Crossing of the Antarctica, (Little and Brown) Adv.
Family of Foxes, Eilis Dillon (Penguin) Adv.
The First Book of Conservation, R.C. Smith (Watts, 1959) I
The First Book of Water, F. C. Smith (Watts, 1959) I
Forbush and the Penguins, Graham Billings (Holt) I
The Forest and the Sea, Marston Bates (Random House) Adv.
From the Eagle's Wing: A Biography of John Muir (Morrow) Adv.
The Golden Footprints, Taro Yashima (World) I-Adv. Poetry
The Great Migrations, Georges Blond (Macmillan, 1956) Adv.
Gull 737, Jean George (Crowell, 1964) I-Adv. Bird tagging
Handbook of Nature Study, Anna Botsford (Comstock,1939) I-Adv.
*Hammonds's Nature Atlas of America, (Hammond, 1952) I-Adv.
Here Come the Beavers!, A. Goudey (Scribner) I
Houses from the Sea, A. Goudey (Scribner) P-I
Incredible Journey, Sheila Burnford (Little & Brown, 61) Adv.
Life of the Queen, Colette Portal (Braziller) ants I-Adv.
The Little Elephant, Ylla (Harper) P-I.
Little Rascal, Sterling North (Dutton, 1965) Adv.
Mrs. Mike, B. & N. Freedman (Medallion) Arctic Adv.
My Side of the Mountain, Jean George (Dutton) Adv.
Nomads of the North, E. Jannes & A. Riwkin-Brick (Macmillan) I-Adv. Arctic
One Day at Beetle Rock, S. Carrigher (pyramids) I-Adv.
One Day at Teton Marsh, S. Carrigher (pyramid) I-Adv. see movies
Otter's Tale, Gavin Maxwell (Dutton) I-Adv.
Pagoo, H. C. Holling (Houghton-Mifflin) P-I the Tidal Bays
Rainbow Book of Nature, Donald C. Peattie (World, 1957) P-Adv.
Rain in the Woods and other Small Matters, G. Rounds (World)
Ring of Bright Water, G. Maxwell (Dutton) Adv. movie
Rinkin' of the Dragon's Wood, T. Colson (Dutton) P-I fantasy
Running Foxes, Joyce Stranger (Ballantine) Adv.
Soil Savers, C. B. Colby (Coward, 1957) I
Spring Comes to the Ocean, Jean George (Crowell) Adv.
Story of my Boyhood and Youth, John Muir (Univ. of Wisc.) Adv.
Stuart Little, E. B. White (Dell-Yearling) P-I City environment.
*Tale of the Meadow, Henry B. Kane (Knopf, 1959) P-I
*Tale of the Pond " " " 1960 P-I
*Tale of the Wood " " " 1962 P-I
*Tia Maria's Garden Ann Nolan Clark (Viking, 1963) P
The Tomtem and the Fox A. Lindgren (Coward) I
The True Book of Conservation, R. Bates (Children's, 1959) P
The Valley: Meadow, Grove and Stream, L&M Milne (Knopf) I-Adv.
Vanishing Wildlife Roy Binney (Dodd) Adv.
*Walt Disney and Golden Press I-Adv. Movies also
    Living Desert Jane Werner, 1954
    Secrets of Life Rutherford Platt, 1957
    Vanishing Prairie Werner, 1955
    Worlds of Nature Platt, 1957
*Watchers at the Pond, Franklin Russell (Knopf, 1960) Adv.
Water for America: The Story of Water Conservation, Graham & Van Dersal (Walck, 1956) I
Water for People, Sarah Riedman (Abelard, 1960) Adv.
Water for the World, E. Helfman (Longmans, 1960) Adv.
Water: Riches or Ruin, Helen Bauer (Doubleday, 1959) I
*The Web of Life, John H. Storer (Devin-Signet) Adv.
The Web of Nature Ted S. Pettit (Doubleday, 1960) I
Wild Season, Allen M. Eckert (Bantam) Adv. read-aloud
*Wind in the Willows, Kenneth Graham (Simon& Schuster) P-Adv. fantasy

Wonders of Animal Architecture, S. Lavine (Dodd & Mead) I.

Junior High and High School Books

Animal Camouflage, A. Portmann (University of Mich., 1959) JH
Animal Ecology, Samual C. Kendeigh (Prentice-Hall, 1961) SH
Animal Life and Lore, Osmond P. Breland (Harper, 1963) JH-SH
Animal Worlds, Marston Bates (Random, 1963) JH-SH
Animals as Social Beings, A. Portmann (Viking, 1961) SH
Annapurna, M. Herzog (popular) JH-SH, man vs. nature; movie
The Balance of Nature, L & M Milne (Knopf, 1960) SH
Brave New World, A. Huxley (Signet) SH
Call of the Wild, Jack London (Macmillan) JH
Cat's Cradle, Kurt Vonnegut (Dell, 1965) SH; science fiction
Cities in Flight, James Blish SH; science fiction
Dune, Frank Herbert (Ace) SH; science fiction
Dune, Messiah, Herbert (Berkley Pub.) SH; science fiction
The Edge of the Sea, Rachel Carson (Signet) JH-SH
Field Book of Animals in the Winter, Ann H. Morgan (Putnam, 1939) JH-SH
Field Guide to Animal Tracks, Olaus J. Murie (Houghton 1954) JH-SH
The Flowering Earth, D. Peattie (Viking) SH.
The Forest, Peter Farb (Life Nature Library) JH-SH
Grapes of Wrath, John Steinbeck (Bantam) SH
*Great American Nature Writing, J. W. Krutch SH and teacher
The Great Chain of Life, J. W. Krutch (Pyramid) SH
The Great Migrations, Georges Blond (Macmillan, 1956) JH
Green Mansions, W. H. Hudson (Airmont) JH
The Hawk Alone, Jack Bennett JH-SH
Immense Journey, Loren Eisely (Vintage) SH
Island of the Blue Dolphins, Scott O'Dell (Houghton-Mifflin) JH
Jude, the Obscure, Thomas Hardy (Harper & Row) SH
King Solomon's Ring, Konrad Z. Lorenz (Crowell-Appollo) JH-SH
Kon-Tiki, Thor Heyerdahl (Pocketbook) JH-SH; movie
Lands and Wildlife of South America, M. Bates (Life Nature Library) JH-SH
The Last World of the Kalahari, L. Van der Post (Morrow) JH
Life and Death of a Salt Marsh, J & M Teal (Ballantine, 1970) JH-SH
The Living Community, A Venture into Ecology, S. C. Hirsch (Viking) SH
The Long-Legged House, Wendell Berry (Ballantine) JH-SH
Look to the River, William Owens (Ballantine) JH-SH
The Man Who Walked Through Time, C. Fletcher JH-SH
The Man with the Red and Green Eyes, H. A. Barnes (Dutton) JH
The Mating Instinct, L & M Milne (Little & Brown, 1954) JH
Moby Dick, Herman Melville (Medallion) SH; man vs. nature, movie
The Mysterious Senses of Animals, V. Droscher (Little & Brown) JH-SH
Natural Partnership: the Story of Symbiosis, D. Shuttleworth (Doubleday, 1969) JH
Nature's Rarities, Philip Street (Dutton, 1963) JH-SH
Never Cry Wolf, Farley Mowat (Dell) JH-SH
1984 George Orwell (Signet) science fiction SH
North With the Spring, etc. E.W. Teale Apollo JH-SH see movie: We Need Each Other
Of Mice and Men, John Steinbeck (Bantam) SH; movie
Old Mali and the Boy, D.R. Sherman (Paperback) JH
The Old Man and the Sea, Ernest Hemingway (Scribner) SH
The Other America, Macmillan social SH
The Outermost House, Henry Beston (Viking) JH-SH Cape Cod
Paths Across the Earth, L & M Milne (Harper, 1958) JH

"Hook"
"The Indian Well"
"The Buck in the Hills"

"Balanced Ecology" Nebula 1 J. H. Schmitz (Bantam)

Movie Bibliography - Language Arts Unit

The movies listed are suitable for an environmental unit. The grade level is given with each listing as is subject, when necessary. *Starred movies * are highly recommended. ** stars are free through the W.M.S.C.P.I. library. *

Adelie Penguins of the Antarctic (1957, Sterling) nature I-JH
Adventures of Huck Finn, (1960, MCM) literature JH-SH
Africa on the Bridge (World Wide) social change SH
African Lion (Disney,1955) nature K-12
Ages of Man (1968, CBS) man's history JH-SH
** *Air of Death (CBC) JH-SH air pollution W.M.S.C.P.I.
Annapurna (France) man vs nature-doct. JH-SH
Antarctic Crossing (1950, Radim) man vs nature JH-SH
The Bear and the Hunter (EBF) man vs nature P-Adv.
*Between the Tides (Contemporary) tidal pools K-12
Bullfrog (Kingscreen Productions) marsh I-SH
Clay (1964, Contemporary) origin of the species-art JH-SH
*Cry of the Marsh (Snyder) death of a marsh Mont. Fish & Game K-SH
Concord...A Nation's Conscience, literature State Library SH
#1-Emerson #2-Thoreau
Down, Decibel, Down (King Screen) noise pollution I-SH
*Dream of Wild Horses (1960, Contemporary) poetry JH-SH
Edge of Abundance (NET) poverty JH-SH
The End of One (Learning Corp. of Amer.) man vs pollution JH-SH
Farthest Frontiers (CBS) Man's Explorations JH-SH
Food Crisis (NET) famine JH-SH
From the Face of the Earth (King Screen) pollution JH-SH
** *Garbage (King Screen) trash W.M.S.C.P.I. K-SH
Good Earth (Brandon) Pearl Buck's Book JH-SH
The Great Adventure (Louis de Rochemont) otters K-JH
Grapes of Wrath (Fox) poverty-dust bowl SH
Hard Day's Night (United Artists-Beatles) awareness SH
Hemingway's Adventures of a Young Man (Paramount) man's growing up SH
The High Lonesome Sound (1963, Brandon) poverty JH-SH
Highway (1958, Radim) I-SH car pollution
The Hunters (1958, Contemporary) man vs nature JH-SH
*Ill Winds on a Sunny Day (U. S. Public Health Service) air pollution JH-SH
*Indian Summer (Folkfilms) destruction of a valley by building a dam. JH-SH
In Search of Man (CBS) Mans's development JH-SH
Iriku (1952, Japanese-Brandon) meaning of life SH
Island of the Blue Dolphins (United World Films) survival JH-SH
Jungle Cat (Disney) nature K-SH
Kite from the Other Side of the World (France, N.Y. International Children's Film Festival) human relations K-SH
Kon-Tiki (RKO) survival JH-SH
Ladybug, Ladybug (United Artists) nuclear attack JH-SH
*Litterbug (Avis) trash K-I
The Living Desert (Disney) the great American desert K-SH
Loon's Necklace (Crawley) myth and nature JH-SH

*Western Montana Science Committee for Public Information, Natural Science Building, University of Montana.

Lord of the Flies (Britain, 1963) survival SH
Louisiana Story (Contemporary, 1948) the Mississippi River JH-SH
Madame Curie (MGM, 1943) biography JH-SH
Magic at Sea (UPA, 1964) exploration JH-SH
Man and Radiation (AEC, 1963) radiation JH-SH
Man of Aran (Contemporary) man in society JH-SH
Mark Twain's America (NBC, 1960) the Mississippi JH-SH
Mary Poppins (Disney) awareness K-JH
** *Men at Bay (King Screen) San Francisco Bay JH-SH
Menken's America (NBC-WJZ 1964) Northeast JH-SH
Moby Dick (United Artists, 1956) literature SH
Mondo Cane (Italy, Audio Film) the world of variation SH
Mrs. Goodall and the Wild Chimpanzees (Nat. Geographic) apes I-SH
Nanook of the North (Contemporary) Eskimos K-JH
Nick (Disney) Eskimos K-Adv.
No Time for Ugliness (Sterling) I-SH
NY, NY (Francis Thompson 1960) the city I-SH
One Day at Teton Marsh (Disney, 1964) marshes K-SH
The Pearl (Mexico, 1948) survival SH
Perri (Disney) squirrels K-JH
*Persistent Seed (Newenhouse, 1964) plants K-JH
Poisoned Air (CBS, 1960) air pollution I-SH
The Question Tree (IBM, free) I-JH
Quetico (Contemporary) JH-SH
Race to Extinction (BBC, 1967) man JH-SH
Rainshower, Churchill (Contemporary) poetry I-SH
The Rebels/Ecology of Design (King Screen) ecologists JH-SH
The Red Balloon (France, Brandon) awareness JH-SH 5th & 6th
The Refiner's Fire (Doubleday MULTI media) student made JH-SH
Ring of Bright Water (Disney) nature K-JH
*The River (Dept. of Agric.) 1937 DuArt the Mississippi JH-SH
The River Nile (NBC,1964) Egypt and the Nile JH-SH
River: Where Do You Come From? (Learning Corp. of America) I-SH
Sammy the Way Out Seal (Disney, 1964) seals K-JH
Scott's Last Journey (Contemporary) Antarctica I-JH
The Sea Around Us (RKO, 1953) based on the book I-SH
Secrets of the Bee World (Disney) Bees K-JH
The Serengeti Shall Not Die (Audio Film) Africa JH-SH
Shakespeare Wallah (Britain) literature & India SH
*Snow (King Screen) poetry I-SH
The Sky Above, The Mud Below (France) nature SH Audio Films
Spring in Ethiopia (NET, 1966) Africa JH-SH
Study in Wet (Contemporary-Groening) rain-poetry JH-SH
Time Is (Contemporary) time I-SH
*Timepiece (Contemporary, 1964) modern man SH
To Adam with Love (Fortress Press) ecology 5th and 6th
Tomorrow's World: Feeding the Billions (NBC, 1967) famine JH-SH
The Unchained Godess (Bell-Telephone-free) weather K-SH
The Vanishing Prairie (Disney, 1954) the American prairie K-SH
Walkabout (Australian News Infor. Bur.) primitive man JH-SH
*We Need Each Other (Xerox-Teale) JH-SH
North with Spring
Journey into Summer
Autumn Across America
Wandering Through America
What Is Ecology (EBF) I-SH

Wheels, Wheels, Wheels (King Screen) car pollution I-SH
White Mane (Contemporary) poetry JH-SH
*White Throat (Canadian Travel Film) bird migration JH-SH
*Who Killed Lake Erie? (Visual Aids Service - U. of Ill.) I-SH
The Worlds of Dr. Vishinac (Educ. Test Services, 69) comparative ecology JH-SH
The World of Jacques-Yves Cousteau (Wolper) the sea JH-SH
A World to Perceive (Net) awareness I-SH
National Film Board of Canada see Contemporary for rental address
Grade School:
Adventures (raccoons)
Animal Movie
Beaver Dam
Fine Feathers (Birds)
The Hoarder
*Paddle to the Sea (a canoe ride in a magic canoe)
The Shepherd

Jr. High and High School, unless otherwise noted:
Above the Timberline (plant ecology)
*Boomsville (cities) also I
Can the Earth Provide
*The Cars in Your Life also I
The Changing Forest
The Columbia
*The First Mile Up (air pollution)
The Flower and the Hive
*Ghost of a River (the Columbia)
In a box-King Size (cigarettes) also K-6
Man and His Resources
Moon Trap (myth)
People by the Billions
Poisons, Pests and People
Population Explosion
The Quiet Racket (noise)
*The Rise and Fall of the Great Lakes
River with a Problem (the Columbia)
*Romance of Transportation also K-6
Sea Otters of Amchitka
Sky
*Spruce Bog
What on Earth?
World at your Feet
World in a Marsh

Addresses of Film Companies (Rental fees range from $10 to $75 depending on company)

Avis Films, P.O. Box 643 Burbank, California 91503
BFA 16MM Ecology Films, BFA Educ. Media 2211 Michigan Ave., Santa Monica, Calif. 90404
Brandon Films, 221 W. 57th St., New York, NY 10019
Churchill Films, 6671 Sunset Boulevard, Los Angeles, Calif. 90025
Crawley Films, Ltd. 19 Fairmont Ave., Ottawa, Ontario, Canada
Contemporary/McGraw-Hill, 828 Custer Ave., Evanston, Ill. 60202
Doubleday Multi Media, Garden City, L. I., New York 11530
DuArt Film Labs., 245 West 55th St., New York, N. Y. 10019
Encyclopedia Brittanica Films, 1150 Wilmette Ave., Wilmette, Illinois 60091

Educational Testing Service, 20 Nassau Street, Princeton, NJ 08540
Folkfilms - Folkcraft Rec. & Pub., 1159 Broad St., Newark, NJ 07114
Fortress Press, Philadelphia, Pennsylvania 19129
International Business Machines, Armonk, New York 10504
King Screen Productions, 320 Aurora Avenue, North, Seattle, Washington 98109
Learning Corporation of America, Columbia Pictures, 711 Fifth Ave., NY 10022
National Education Television, 12 Columbus Circle, New York, NY 10023
Hank Newenhouse Films, 1017 Longaker Road, Northbrook, Illinois 60069
Radim, 220 W. 42nd Street, New York, NY 10036
Rochemont, Louis de Rochemont Assoc., 18 E. 48th St., New York, NY
Sterling Educ. Films, 241 East 34th St., New York, NY 10016
Thompson, Francis Thompson Prod., 935 2nd Ave., New York, NY 10022
Walt Disney Prod., Educ. Film Div., 350 So. Buena Vista Ave., Burbank, California 91503
Wolper Productions, 8544 Sunset Blvd., Los Angeles, California 90069
World Wide Pictures, Box 1368, Burbank, California
Xerox Films, High Ridge Park, Stamford, Connecticut 06904
**W.M.S.C.P.I. Library, Natural Science Building, Univ. of Montana, Missoula 59801
Also has slides available, and will have a film on pollution in Montana by Swain Wolfe available next fall.

Audio Film Center, 24 McQuesten Parkway, S., Mt. Vernon, New York 10020

Foreign films may be ordered through the Embassy or through Audio-Films for the most part. A good reference is Feature Films on 8 mm and 16 mm.
by James L. Limbacher
Educ. Film Library Assoc.
250 W. 57th Street
New York, NY 10019
Cost $7.50

The Pearl, John Steinbeck (Bantam) JH-SH
Reading the Landscape: An Adventure in Ecology M. T. Watts (Macmillan, '51) JH
The Red Pony, John Steinbeck(Bantam) JH
Scott's Last Expedition (Dodd & Mead) Antarctica JH
*The Sea Around Us, Rachel Carson (Signet) JH-SH
*The Sense of Wonder, Rachel Carson (Harper and Row) JH-SH
The Study of Plant Communities, H. J. Oosting (Freeman, 1956) Teacher Adv.SH
*Sierra Club - Ballantine Series
An excellent set which combines major nature writers and photographers - some of the titles are:

Gallepagos Islands two volumes Darwin
Glacier Bay
In Wildness is the Preservation of the World - Emerson and Thoreau
The Last Redwoods Hyde
No Man Apart Robinson Jeffers
On the Loose two high school students
This is the American Earth Ansel Adams
The Wild Cascades Eliot Porter

*Tide Pools and Beaches, E. Clemons (Knopf, 1964) JH-SH
Time is Short and the Water Rises, J. Walsh (Ballantine) JH-SH
Troubled Waters, D. P. Mannix (Ballantine) fiction JH
The Twelve Seasons, J. W. Krutch (Apollo) SH
Vanishing Animals: Preserving Nature's Rarities, P. Street (Dutton, 1963) SH
What's Left, B. Roueche (Ballantine) JH-SH
Where There is Life P.B. Sears (Ballantine) JH-SH
The White Desert, N. Barber (Crowell) JH
White Fang, Jack London (Macmillan) JH
*The Whole Earth Catalogue (Portola Institute - Menlo Park, Ca) JH-SH
Wild Animals I Have Known E. T. Seton (McGraw-Hill) JH
Year of the Gorilla, G. Schaller (Ballantine) JH-SH
The Year of the Last Eagle L. T. Rienow (Ballantine) SH science fiction

Poetry

Earth Household Gary Snyder (New Directions)
Hawk in the Rain Ted Hughes (Harper and Row)
Introduction to Poetry X.J. Kennedy (Little & Brown)
Riding the Earthboy Forty Jim Welch (World)
*Voices vol. 1-6 ed. Geoffry Summerfield (Rand-McNally)

Selected poems

"Blowin' in the Wind" Bob Dylan
"The Day the Road Came" Rod McKuen
"The Eagle" Alfred, Lord Tennyson
"Ladybug, Ladybug" Nursery rhyme
"The Lemmings" John Masefield
"The Old Woman Who Swallowed a Fly"
"Thirteen Ways of Looking at a Blackbird" Wallace Steavens
"When Serpents Bargain for the Right to Squirm" E. E. Cummings

Short Story

The Watchful Gods and Other Stories, Walter Van Tilburg Clark Signet SH

8

THE STUDY OF A POND ENVIRONMENT

Dan Block

Concept:

Organisms and the abiotic components of any environment are interdependent and a part of the food web.

Objectives:

Teacher - to help the students understand that all organisms of a community, including man, are interdependent.

Students -

1. To recognize the three basic groups of organisms which make up every community.
2. To observe the roles of these organisms in their environment.
3. To learn how to study an environment.
4. To relate changes in the environment to changes in the relationships of living organisms.
5. To evaluate man's role in the maintenance of the environment.

The following guide is designed only for either junior or senior high school use. The basic outline is as follows:

A. Introduction of the concept and preparation of the class

B. Planning the field trip

C. Follow-up activities

D. Appendix

E. Bibliography

Introduction - Why Study a Pond?

Today man is concerned with the protection of the environment more than at any time in history, and the reasons for concern are real. Some problems such as hunger and disease have always been present in the history of mankind. Others, covered by the broad term "pollution," recently became important, and resulted from the greatly increased technological developments of the twentieth century which enabled man to exploit the earth at a much greater rate than ever before. The average American is considered to be the equal of 20 natives of India--as measured by the consumption of natural resources during his lifetime.

Our industries, commerce and households annually dump millions of tons of solid wastes and chemical pollutants into the water and air. As a result some rivers are so polluted that they have caught fire, and many persons with respiratory ailments have been forced to move from certain cities with air pollution conditions. In recent years many new plants and animals have been added to the list of endangered species -- the blue whale, the largest animal on earth, and according to some biologists, even man himself.

Why is it necessary to study a pond to learn how to take care of our environment? Plants and animals are not randomly scattered around the earth but exist in highly complex communities which are determined by geology and climate. These communities can be classed as aquatic or terrestrial, and further subdivided into various land or water habitats.

Life on land occurs from below sea level in such places as Death Valley and the Dead Sea to regions above timberline on our highest mountains. It ranges from tropical rainforests, which have the greatest variety of species of organisms of any place on earth, to the Arctic tundra where only a few highly specialized plants and animals can live. Aquatic life is found in Antarctic seas so cold that some fish do not have red blood cells for the transportation of oxygen while, at the other extreme, brightly-colored algae live in Yellowstone Park pools hot enough to cook flesh.

But, in spite of the wide range of conditions under which life can exist, all habitats have a basic pattern in the compostion of the life forms present. They consist of three inter-related groups of organisms essential to the maintenance of a balanced environment. These are the producers, the consumers and the decomposers. A favorable habitat will have many species in each group; a severe one will have very few, but all three will be represented.

The producers are the green plants which contain chlorophyll and manufacture organic compounds through photosynthesis. The sun provides the original source of energy for this process even though many have gone through a number of energy transfers first.

The consumers are the predator chains, the herbivores and carnivores which feed upon vegetation and upon each other. These chains may be very short, as in the case where man lives primarily on a diet of rice, or they may be quite long and complex with many predators involved.

The decomposers are the microbes, the bacteria and the fungi which cause decay. They are the only living organisms capable of breaking down organic matter and recycling it so that it can be used once more in the food web. The decomposers are found in abundance along the bottom of the pond, strewn in a thin layer where the mud and water meet. They also are found in great numbers where plant plankton forms are abundant and in shallow water among emergent plants. More than two million bacteria may be present in one teaspoonful of bottom sediment. Foul-smelling gases may be produced as a result of the necessary activity of the decomposers, but decomposition of dead organisms is rapid in the favorable temperatures of ponds during the summer. It is the activity of the producers and the decomposers which determines the ability of the environment to support all other populations.

A pond contains an abundance of organisms in each of the three basic groups. Many of them are easy to collect and to observe so that the study of a pond will help one to learn concepts which can then be applied to any habitat. The United States has over one and a half million ponds. No two are

ever quite alike, and no single pond ever remains the same for long. Ponds may be natural or man made. They may be temporary or permanent, but some type of pond is available in almost every part of the country for students to study.

Preparation of the class

A. Physical characteristics of a pond habitat (1) (2)
   - size, depth, temperature, pH, light penetration, substrate

B. Ecological niches - rocks, mud, logs, vegetation

C. Biogeochemical cycles (3)
   - water, carbon dioxide, clacium, oxygen, nitrogen, phosphorus

D. The web of life (1) (3) (4)
   1. Producers - algae; submerged, floating and emergent higher plants
   2. Consumers (first, second and third order)
      protozoans, daphnia, cyclops, planaria, fresh-water shrimp, snails, clams, insects, crayfish, frogs, birds, mammals, etc.
   3. Decomposers - bacteria and fungi

E. Ecological pyramids - of number, biomass and energy (4)

F. Supporting audiovisual materials
   1. The Pond. International Film Bureau 16mm (c), 20'.
   2. Under-Rock Environment. Ealing Film Loop #81-5886/1 color, 4' elementary $21.50.
   3. Plankton: Food Webs and Feeding Relationships. Harper and Row Film Loop #81-6850/1 color, 4' $24.95.
   4. Animal and Plant Communities: The Pond. (Interdependence of Living Things series) McGraw-Hill, Film Strip 1961.

Planning the field trip (1) (2) (5) (6) (7)

A. Materials needed: notebooks, thermometer, nuts, jars, buckets, compass, tape

B. Team assignments - to vary with amount of work

   1. Mapping -- sketch pond; show directions, size, depth (if possible),

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(1) Amos, The Life of the Pond.

(2) Morgan, Field Book of Ponds and Streams.

(3) BSCS, Green Version Biology.

(4) Odum, Fundamentals of Ecology.

(5) Knudsen, Biological Techniques.

(6) Morholt, et al, A Source Book for the Biological Sciences.

(7) BSCS, Field Ecology Lab Block.

(8) Welch, Limnological Methods.

nature of surrounding area, vegetation types

2. Environment -- note indications of man's activities, including domestic animals, on the nature of the pond. Estimate age of pond (young or old) from development of vegetation and amount of open water left. Is it temporary or permanent, man-made or natural? Source of water supply?

3. Producers -- collect and record nature of green plants and relative abundance - algae, mosses, submerged pond weeds, floating forms, rushes, sedges, cattails, etc.

4. Consumers -- collect where possible, note abundance
   a. Invertebrates -- plankton, worms, mollusks, crustaceans, etc.
   b. Vertebrates -- fish, amphibians, reptiles, birds and mammals. Note evidence of their presence from tracks, droppings, homes; plaster of paris casts of footprints can be made

5. Decomposers -- collect bottom sediment and pieces of debris and vegetation for bacterial cultures

6. Water chemistry -- temperature, color, odor, (pH, methyl orange alkalinity, oxygen content) (8)

Follow-up Activities

A. Bulletin board display; current articles and pictures on ponds and pond ecology.

B. Laboratory

1. Observe living organisms in aquaria and with micro-projector.

2. Make a home-made pond (1).

3. Separate producers and consumers into major toxonomic groups as far as possible.

4. Use bacteriological culture media to demonstrate presence of decomposers (7).

C. Classroom

1. Distinguish between different levels of consumers.

2. Diagram individual food chains.

3. Diagram a food web with all organisms accounted for.

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(1) Amos, The Life of the Pond.

(7) BSCS Investigation 6.2.

(8) Welch, Limnological Methods.

4. Discuss the following:

   a. How do seasonal changes affect the food web?
   b. Why are there so many different kinds of organisms?
   c. Why are herbivores more abundant than carnivores?
   d. Why are most life cycles short?
   e. What changes will occur if -
      (1) a herbivore is removed from the web?
      (2) a carnivore is removed from the web?
      (3) cattle start using the surrounding area and drink from the pond?
      (4) the land is plowed up to the edge for crops?
      (5) a feed lot drains into the pond?
      (6) a class visits the pond yearly for study?
      (7) a class visits the pond daily?
      (8) the pond is filled in?
      (9) all ponds are filled or drained?

   f. Any questions which fit local conditions

Suggestions for the Teacher

Allow adequate planning and preparation time to insure success of the field trip.

Obtain permission from school administration and parents of students, arrange for transportation and secure additional supervisory help well in advance of the trip.

Timing is important. Late spring or early fall are the best times but local conditions must be considered. Rich plankton populations can often be observed and collected through holes cut in the ice during the winter.

A piece of liver tied to a string can be used to attract animals such as planaria and crayfish if allowed to rest on the pond bottom for a short time. Minnow traps are effective for many kinds of organisms if varied baits are used.

Equipment need not be elaborate. A large nylon stocking with a wire loop can make an effective plankton net.

Temporary ponds formed by spring rains or melting snow can be very rich. They may abound in mosquito larvae, daphnia, copepods, fairy shrimp, etc.

A 35mm camera to be used in taking colored slides is an excellent teaching aid.

Student talents should be used wherever possible. Those with artistic ability might be interested in sketching the class activities; writers can submit articles to the school paper. A complete report of the trip and findings can be put together so that each student has a copy.

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ENVIRONMENTAL CONCEPTS AS A PART OF JUNIOR HIGH SCHOOL STATE AND LOCAL HISTORY

9

John L. Olsen

Integrating Environmental Concepts Into the Study of Local and State History

The first step in presenting environmental concepts to the junior high school student is to make him aware of his environment. In local and state history the student can become aware of what the environment was in the past and how it has changed. Awareness can best be brought to the student by integration of environmental ideas into the structure of the course. The following are ideas for that integration.

Montana history is first concerned with the original natural history of the state, which could date back to prehistoric times. The student can have an idea of how nature has slowly changed in the area of the state being studied. The student should be exposed to how the early man lived and how he made use of natural resources for his existence. The history would then take the natural progression to the arrival of the men who founded the state as it fits into the United States. An example would be the study of prehistoric man, then the Indians, then the first white men in the area. The environment of these early men should be stressed as well as the change, if any. The student should know how early man in his area lived with his environment and what effects he had on it. This method of looking at early man and his environment should be localized. Any connection to early man and the community location gives the students a chance to observe remaining signs of early man.

The natural resources and their attraction to the pioneers should be stressed. How did they use what they found? What signs of the settlers can be seen today? These questions can draw a relationship between the early settlers in the area and the environment. One example would be to point out the mine dumps in a mining state. One could also point out areas of forest that were cleared for farming. There are many connections that can be drawn between early settlers and present-day environmental conditions.

The local level should be used for the junior high group when possible. If you can trace the early history of the area to today, the student can see what has happened in his own "backyard."

In the study of a state or locality there are many examples of changes in the economic base of a community because often a natural resource has been depleted or misused. There are examples of depletion of a resource causing the death of an entire area. An example would be a prosperous mining area now a ghost town. There are examples of lumbering areas over-cut or farming land poorly managed. The dust bowl days were a good example of poor land management. The teacher should consistently tie past events to present environmental conditions. There are many such ties in every state and community.

It is important to emphasize the natural resources in an area and how the area grew or died in relation to the natural resource supply. It is very important that the students know the natural resources on which his home area is based, and how it affects his family.

When the student has become aware of the natural resource basis of his community and state, and how it may have been misused or is still the center of the economy, the student's awareness should then be carried into the present and future. What is the environmental future of his state and community? Upon what natural resources do the state and community depend? In what condition are those natural resources today? What can the student do today and in the future to maintain or improve the environment? What is the state and community doing about the environment? What has the community done in the past about the environment? What will need to be done in the future? What changes must be made to improve the environment of the state and local area? These are all questions which must be brought into local and state history classes and answered by teacher guidance, reading, asking people in knowledgeable postions and by personal student exploration and research.

The prime objective presented in this cell is to make the student aware of the historical facts of the environment and how man has depended upon, used, and in many instances, changed the environmental factors in a specific location. The teacher would make environmental awareness a part of the course and not tack it on to a section which seems separate and unrelated.

Activities for Emphasizing Environmental concepts in Local and State History

The first part of this cell contained ideas to make environmental awareness a part of the traditional class situation. In this part, the emphasis will move from the integration to specific activities based on environmental concepts. The activities are designed to be done in a junior high social studies class. It is planned that these activities will occupy a complete period of time. There are classroom and outdoor activities listed. If we are to become aware and motivated to action about the quality of our natural environment, we must place ourselves in that natural environment. Just as a football game cannot be played in the classroom, environmental involvement cannot be reached without experiences in the natural environment..

In the following cell the activities will be arranged in three groups. Group I will be awareness activities. Group II will be motivational or "seeing" activities. Group III will be action activities. Each activity will be divided into two parts. The first part will be the environmental concept that the student will be confronted with and the second part will be the method that will be used to present the concept.

GROUP I - AWARENESS ACTIVITIES

CONCEPT: All that we have are products of natural resources.

METHOD: Have members of the class identify various favorite possessions. Have the class discuss which natural resource or resources were directly or indirectly responsible for the possessions. Introduce the fact that our natural resources are the foundation of our natural environment.

CONCEPT: Man's appreciation and protection of natural things around him.

METHOD: On a very beautiful day ask the students what they would like to do if they could do anything they wanted. Have each student write that activity down and answer the following questions if they can.

1. What natural resource would you be using?
2. What laws protect that resource?
3. What might lessen your enjoyment of that place?
4. How can that place be protected for future use?

Discuss the answers with the students and their reason for the answers.

CONCEPT: Natural resources have a very strong effect on the way man lives.

METHOD: Discuss with the class the natural resources that are in the area of the school (city or locality). Ask these questions.

1. How did the natural resources affect the early settlers in this area?
2. How do natural resources affect the area today?
3. How have the natural resources changed since the founding of this area?
4. What laws protect the resources in this area?
5. Why do we have laws that protect natural resources?
6. In what ways would this area change if certain resources were no longer available?

Give the students one or two days to research the answers, then discuss each question and the various answers the student give.

CONCEPT: The natural environment has certain intangible values.

METHOD: Show the class a beautiful natural picture, slide or movie. Ask the students if they liked it. (Use something that most students will enjoy.) Have them tell why they found it pleasurable. Introduce the term "aesthetic" and try to form some sort of definition. Discuss what value aesthetic things may be to man. The same method can be used by showing the class something they find distasteful, or the instructor could show contrasting scenes to foster feeling and reaction.

CONCEPT: Man's modern technology can severely alter nature to the extent that it may be dangerous to man.

METHOD: Have several students bring an old tool to class. The instructor should locate select tools of old design. Have the class inspect the tools and determine what man used them for. When the students have discussed the tools have them try to name tools or machines that can do the same job the old tools were designed to do, but better and faster. Discuss how man's new tools or machines could lead to the destruction of the natural environment. The discussion might also point out ideas how these same tools might help to improve the natural environment.

CONCEPT: Several federal agencies are designed to help in the maintenance or improvement of the environment.

METHOD: Schedule representatives of governmental agencies to talk to the class on the environmental conditions of a specific area and what is being done to maintain or improve the environment in the immediate area. Such groups would be the Park Service, Forest Service, Soil Conservation Service, State Fish and Game Department and other agencies that may be in the area.

CONCEPT: Many citizens in the community are concerned about the quality of our environment.

METHOD: Schedule representatives from service clubs, various environmental minded organizations and interested, informed individuals to speak to the class about the environmental quality of the area. These people should be interdispersed with the government agency people.

CONCEPT: Most recreational activities and areas depend on the natural environment.

METHOD: Have the students list recreational activities carried on in the area that depend on the natural environment. Evaluate each activity with the following questions.

1. What natural resources does the activity use?
2. What effect does the activity have on the natural environment?
3. Are recreational activities such as this important? Why?
4. What would be the effect on the area if this activity did not exist?

Discuss the answers and the part recreation plays in the structure of the community.

CONCEPT: Industry can be good for man and it also can be bad.

METHOD: Assign two groups of students to learn all they can about a local industry. Have one group look for negative things about that industry, keeping in mind the environment aspect. Have the other group look for the beneficial aspects of the industry. Bring the two groups together in a small formal debate; let the class react to the ideas.

GROUP II - MOTIVATIONAL ACTIVITIES

CONCEPT: Many people in the community are involved in occupations which deal directly with conservation of the natural environment.

METHOD: Plan short trips to the offices of various agencies such as the Forest Service, Soil Conservation Service and other such agencies. Have the students consider questions about what is being done about environmental quality by each office.

CONCEPT: We could prevent a large amount of trash accumulation by using reusable containers.

METHOD: Have examples of several "throw-away" containers or have students bring examples to class to see how many are around the average home. Discuss how use of these affects the amount of trash each person throws away each day. If possible, have some containers that can be used in place of the throw-aways. Discuss how changing to reusable containers could affect our daily lives. Ask the students whether they could sacrifice convenience to lessen the trash problem.

CONCEPT: The people of the community may or may not be interested in the environmental quality of the area.

METHOD: Decide as a class what the students want to know about people's thoughts on environmental conditions in the community, then make up a question sheet the students could ask the people of the community to fill out and return. The math class could be drawn into this project to help figure results of the study. The English class could write the questions. This would be an excellent way to use a multiple discipline approach, and to get other teachers involved.

CONCEPT: We sometimes become so accustomed to seeing pollution that we don't notice it.

METHOD: Take a short walk from the school and look at places well known to students. Point out and have the students watch for things which are lowering the quality of the environment. Ask the students what they might do to improve the situation, and why they should do something about it.

CONCEPT: A natural resource can have many uses to man.

METHOD: Take the students to look at a single tree. Ask them what they might use that tree for and whether the tree could be used again. If some of the uses of the tree would cause the tree to die, discuss how long it would take for a new tree to replace it. When they decide how long it would take a new tree to grow, discuss how old they would be and what they think they might be doing. Have the students bring out uses that kill the tree and uses that would not kill the tree.

CONCEPT: Many people in the United States are interested in the quality of the environment.

METHOD: To give the students first-hand relationship with various groups in the U.S., divide the class into small groups and have them send to the Sierra Club, Wilderness Society, Wildlife Federation, etc., for information about the need for a high-quality environment. When the materials are received, have each group show the class the information and materials and how interested students could be a part of these various groups. Through personal contact the students can establish relationships with interested organizations and groups.

CONCEPT: Sound is one of our environmental polluters.

METHOD: Let the students listen to selected natural sounds such as birds and rushing water. Contrast these sounds with man-made sound intrusions. Try to use man-made sounds the students will recognize, and let them react to the sounds they liked best and tell why.

CONCEPT: Concern over the environmental quality is one of the world's major concerns today.

METHOD: Divide the class into groups. Ask each group to make an environmental "current events" bulletin board and keep it up to date for a specific period of time, rotating the responsibility. The class will have a source for knowing what is happening in the world, state and community concerning environmental quality.

CONCEPT: Man must decide between material wealth and natural wealth if we are to keep the Earth a safe place to live.

METHOD: Take the class to a beautiful undisturbed spot near the school or show slides of a location familiar to most of the students. Tell them to pretend that they all own part of the land. Then tell them that you will make a deal with them. "If you will let me build a steel mill on that property I will give each of you ten dollars." Keep increasing the price till most of the students think it is a good deal and accept it. Tell them this is the sort of thing they will be faced with the rest of their lives. They will have to make a decision between natural wealth and material wealth.

GROUP III - ACTION--DOING ACTIVITIES

CONCEPT: Everyone can work to improve and maintain the environment.

METHOD: In cooperation with the English department write and produce a video tape television show that illustrates how the junior high student can help clean up the environment. Students, parents and civic groups can see what the students are thinking about and that they are interested in environmental quality.

CONCEPT: Students do not pick up trash around the school, and with awareness this can be improved.

METHOD: Have the class pick up trash around the school building and grounds for a week. Allow the trash to accumulate for a week and then show the rest of the student body how much trash was left around the school by carelessness. This display should encourage the students to use the proper containers for paper and other trash and clean up the school as a start on the improvement of the world environmental quality.

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The term soil refers to the outer layer, or crust of the earth, and is distinctly different from the bedrock below it. Soil is a living biological community which contains a vast population of bacteria, actinomycetes, fungi, algea and protozoa. It is the living skin of the earth in which many biological and destructive activities of organic material takes place as well as the weathering of rocks.

Soil is sometimes referred to as the home of the plant; as such it serves as a source of essential elements and compounds for plant growth, to anchor and support the plant, and to provide storage place for the water so necessary for plant growth.

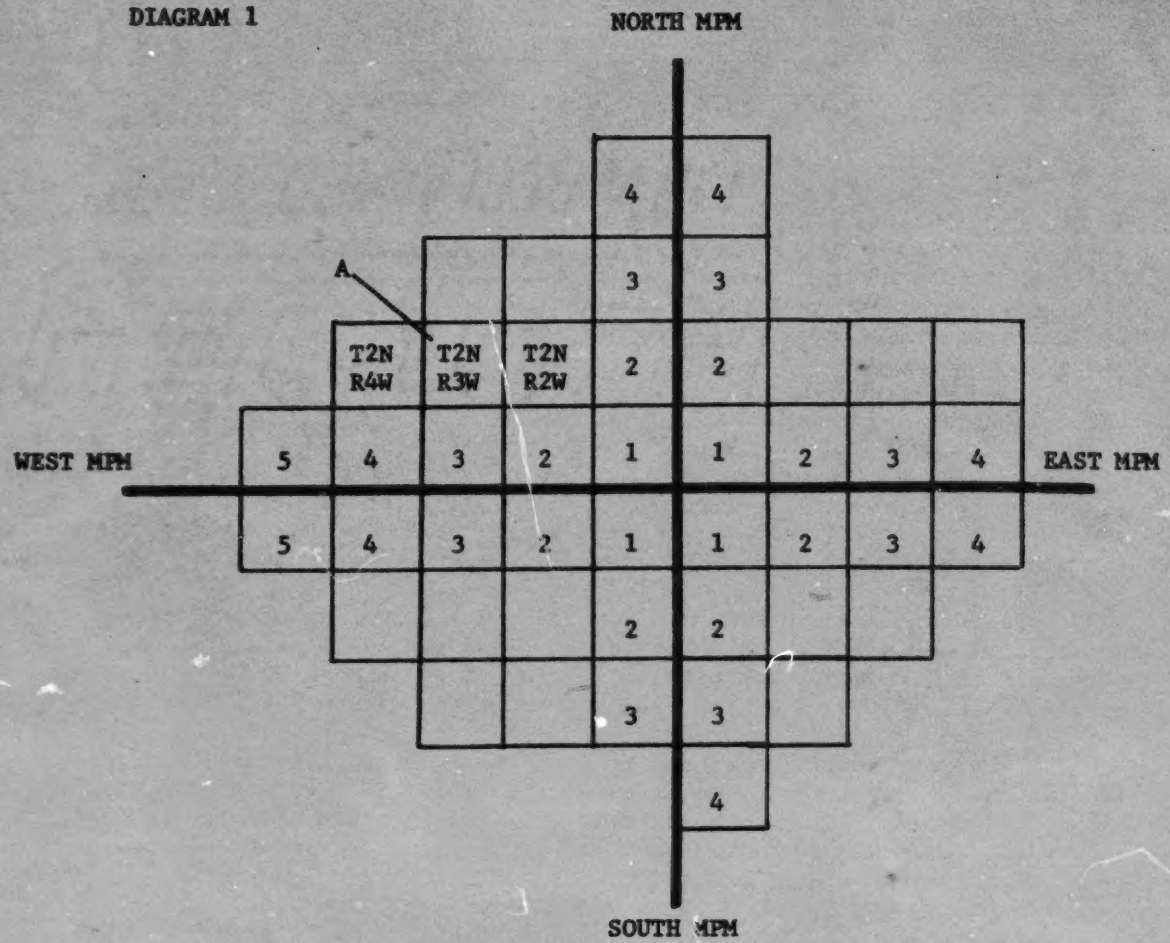
Soil determines the type of flora that will grow, and this living flora helps give the soil its characteristics. Thus one can look at the soil and determine the types of plants it will grow; at the same time one can take a sample of the plants in an area and determine the type of soil there.

In this investigation we are going to look at the soils in your area, identify the type, and map the location. Thus, we will be producing a soil map for your area; at the same time we will indirectly be mapping the vegetation of the area. Of course, another important factor, the abiotics of the area determine the plants and soil in the first place.

Before we go any further into the investigation of soils, let's look at how a map is constructed.

Within Montana is a point called the principle meridians intersection. This point is based on the lines of latitude and longitude. From the principle meridian Montana is divided into townships. On the diagram (see diagram 1) the lines of latitude are called township lines and the lines of longitude are called range lines. Moving out from the principle meridian intersection in all directions we begin to number the squares called townships. The range and township lines are used to identify a specific township. Study diagram one until you are able to name all the townships shown. Notice that direction from the principle meridian is also used to identify a township. Looking at Diagram 1 and township marked A you would identify it as Township 2 North, Range 3 West, or T2N, R3W.

DIAGRAM 1



When we are mapping an area we will want to use smaller divisions than townships for a township contains 36 square miles. Look at Diagram 2 and notice that the square miles are numbered from right to left and from top to bottom. These square miles are numbered from right to left and from top to bottom. These square miles are called sections and contain 640 acres. On two sides of a township, the north and west sides contain correction lines to compensate for the fact that the earth is a sphere rather than a flat surface. The sections bordering the north and west sides may not always have exactly 640 acres in them.

If you look at section 16 you will see that it is divided into quarter sections of 160 acres. Thus the sections can be divided into smaller units down to 2 ½ acres in size. Refer to Diagram 3 to see how this is done. Notice that the smallest divisions are given first. The third example from the top would read the southwest quarter, of the southwest quarter of the southwest quarter of section 16 of township 4 north, range 8 east.

DIAGRAM 2

DIVISION OF A TOWNSHIP
INTO SECTIONS AND
A SECTION INTO QUARTERS

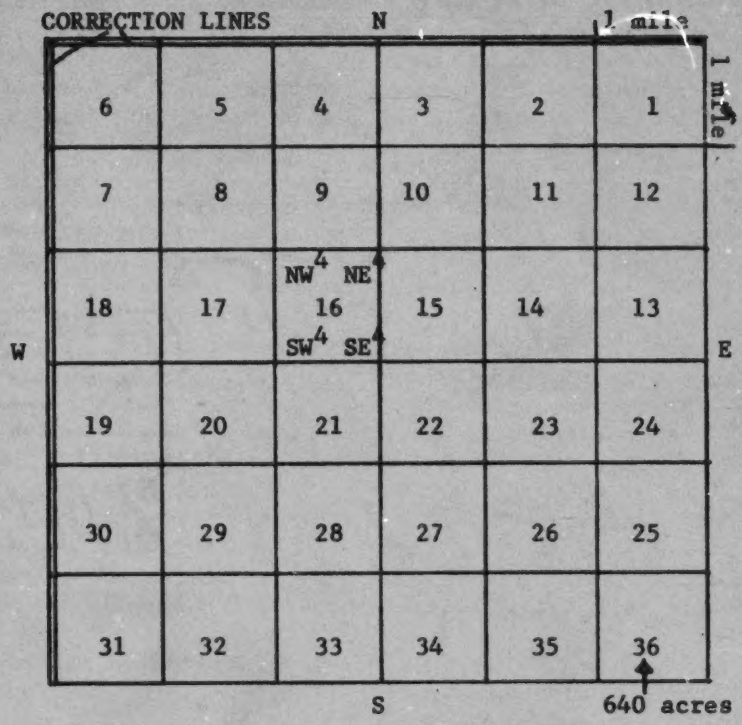
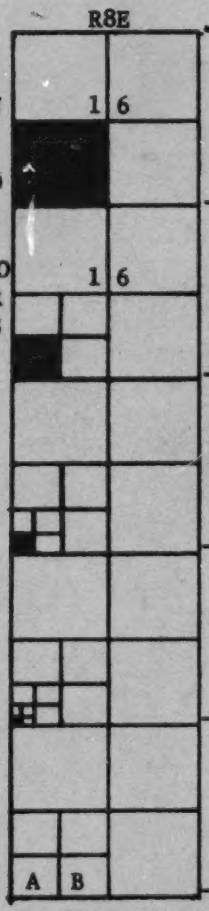


DIAGRAM 3



METHOD USED TO BREAK DOWN A SECTION INTO ITS SMALLER LEGAL UNITS

SW^4, Section 16, T4N-R8E (160 ACRES)

40 160 640
SW^4-SW^4, SEC. 16, T4N-R8E (40 ACRES)

10 40 160 640
SW^4-SW^4-SW^4, SEC. 16, T4N-R8E (10 ACRES)

2½ 10 40 160 640
SW^4-SW^4-SW^4-SW^4, SEC. 16, T4N-R8E (2½ ACRES)

A is SW^4_4-SW^4_4, SEC. 16--40 ACRES
B is SE^4_4-SE^4_4, SEC. 16--40 ACRES
THEY CAN BE COMBINED TO READ
S^2_2-SW^4, SEC. 16 80 ACRES

Divisions which are smaller than 2½ acres are described by lots, but for our purposes here 2½ acre areas are small enough.

Using the above information you should now be able to find a location on a map from a description or write a description for a location.

Let us now return to our consideration of soils. As you know, the plants of an area - if they have been there a long time and have not been disturbed - are called climax plants, or it is said to be a climax community. The two abiotic factors which influence the plant community the most are the temperature (radiant energy) and moisture. In general, as one goes up in elevation the temperature is cooler and the amount of annual precipitation increases. Thus, there is a series of plant communities as one ascends in elevation. Refer to Diagram 5 for a general picture of the plants that occur at the different elevations in Powell County valleys. The diagram shows that one community abruptly ends and becomes another. However, this changing of communities is more of a blending of one into another and is called an ecotone.

The plants that are in an area, because of their biochemical makeup, directly produce the character of the soil. This is accomplished through leaching of water through the decaying plant material in the soil, making humus. From this leaching and depositing of materials and ions at different levels in the soil we are able to describe several distinct patterns. This pattern or layering can best be seen by digging a hole in the ground or by examining a road cut. This cut to expose the soil is called a soil profile.

A soil profile is made up of four major horizons or layers: the A horizon of maximum biological activity, B horizon which is the accumulation of suspended materials from the A, the C horizon of weathered parental material, and the D horizon which is the undecomposed bedrock. Diagram 4 shows these horizons in a generalized soil profile.

The degree of horizonation indicates development and a new soil classification system is being developed. This system is quite complex; however, looking at only the general orders of soils based on the characteristics of the soil profile will serve as an introduction to the system and as a useful tool in our studies. The soil orders given here are based primarily on the horizons present in a soil profile.

DIAGRAM 4

A_{oo}	litter, loose leaves and organic matter
A_o	organic debris, partially decomposed
A	dark in color, high in humus
B	lighter in color, maximum clay accumulation of materials leached from above. Leaching here may be quite high.
C_{ca}	Maximum accumulation of $CaCO_3$ (hardpan)
C	weathered parent material
D	bedrock

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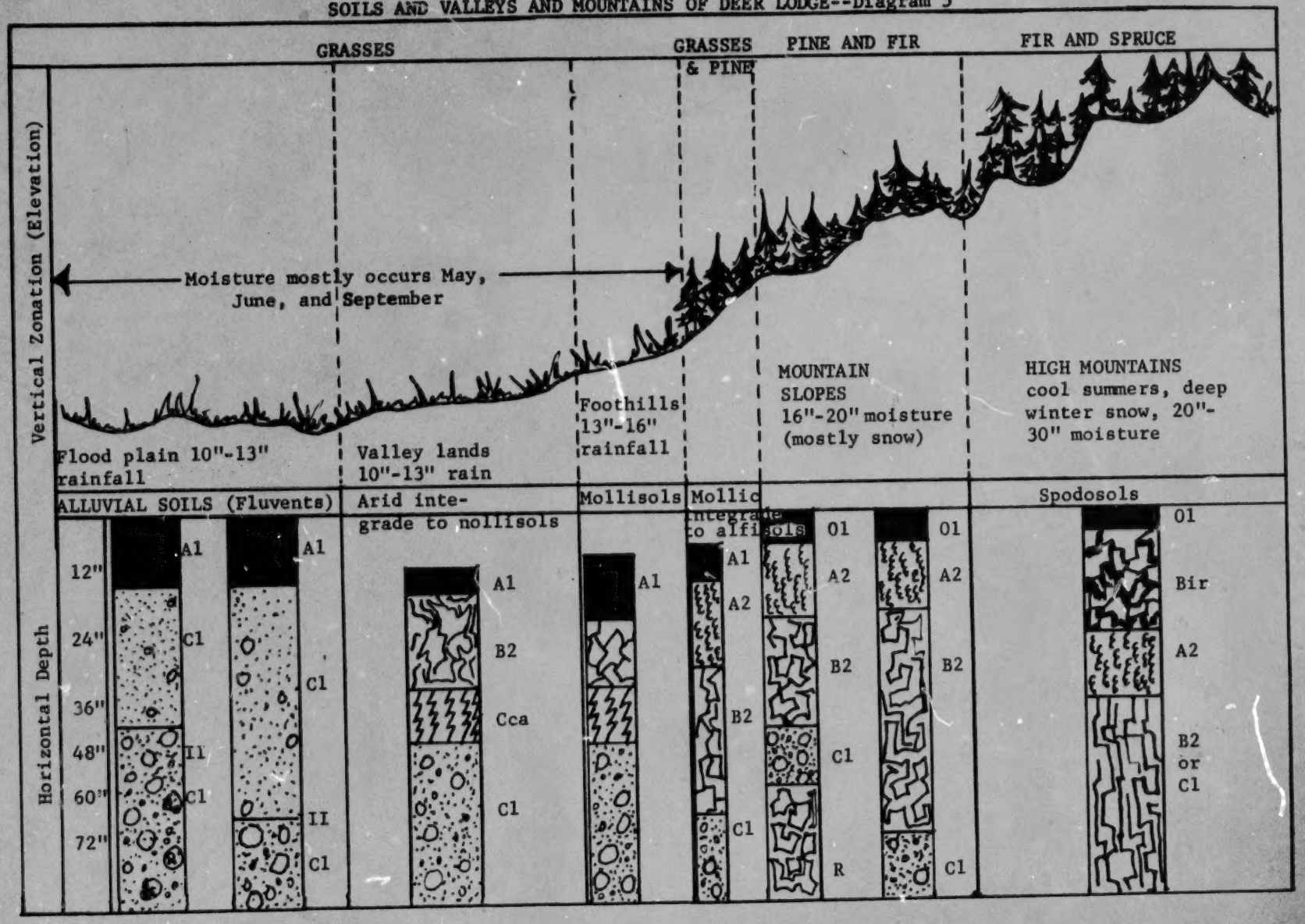
SOILS AND VALLEYS AND MOUNTAINS OF DEER LODGE--Diagram 5



Terms Used in Soil Description

ALPHASOL--Very much climatically influenced, associated with forests, particularly the coniferous forests. Usually a good Aoo horizon of litter, a dark A horizon followed by a light gray A_2 and B horizon. Clay accumulation evident in the B horizon which is usually a yellow brown color. May have a $CaCO_2$ accumulation (bubbles in the presence of dilute HCl). A horizon structure usually weak.

ENTISOL--Practically no development. None or perhaps a poorly developed A horizon in the profile. Example--new river bar may have a barbled look.

INCEPTISOL--Few horizons (one or two). Soil profile just getting started.

MOLLISOL--Upper horizons high in organic matter. Good black surface. Usually good granular or crumb structure. May have a C_{ca} (calcium carbonate) layer at the top of the C horizon. These are soils developed under the grasslands.

SPODOSOL--Found under Spruce and Alpine Fire at high altitudes. Climatic conditions are heavy snow pack, low temperature, and heavy precipitation. The litter horizon is found first followed by a B horizon with iron deposit (Bir). This is followed by an A_2 which is thin or absent, followed by a B_2 or C horizon.

VERTISOL--No horizons because of physical mixing due to large cracks and the continual sloughing of materials down to a considerable depth.

Many additional suffixes are used in this system to help classify soils, a few are listed here that you will be using, but this is only a small number of the many available to use.

Al--presence of an A_2
Aqu--wet
Cry--cold less than 47°F. annual
Ent--young soil, little development
Ept--moist soil weak horizons
Fluv--alluvial soil (water carried)
Id--arid-dry soil
Lithic--bedrock less that 20" depth
Ochr--light-colored A horizon
Oll--dark-colored A horizon
Pale--old development--deep
Terr--usually hot and dry

Using this system then a Palecryoll mollisol is a grassland soil which is old, more than 24" to bedrock, cold, with a dark colored A horizon.

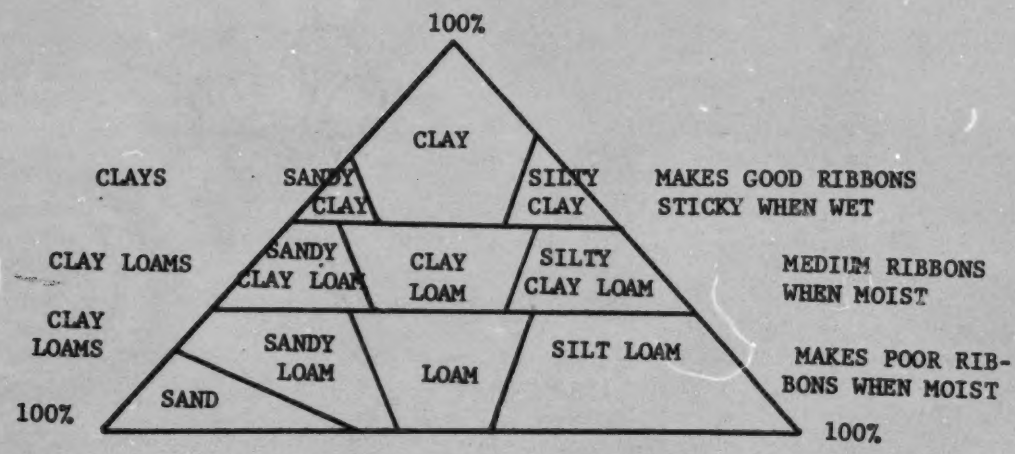
Looking at Diagram 5 we now have the plant communities and their soil profiles.

The other general characteristics of the soil other than the organization of the horizons is the texture of the soil. Texture refers to the proportions of different sized particles in the soil on a percentage basis. This property is important for it is directly related to the total surface area of the soil thus affects many phenomena and has an effect on management practices.

Soil class names consist basically of four terms: sand, silt, clay and loam, used either as nouns, adjectives or both. An example of this would be a soil which is primarily clay is called clay, but if there is enough sand to modify the texture it is called a sandy clay.

The exact percentage of each of these groups can be done through mechanical analysis using a hydrometer, but for our purposes the texture can be determined by feel. To do this use the modified textural triangle as in Diagram 6.

DIAGRAM 6



This triangle is based on three materials: clay, sand and silt. The percent of each makes up the different soils. To determine this by feel, place a small amount of the soil in the palm of your hand, wet it drop by drop and bring it to the consistency of putty. Then roll the soil between the fingers and make a ribbon of it. If it is a clay it will form good ribbons; a clay loam will form a fair ribbon and a loam will form poor or no ribbon at all. To determine which of the groups it is within a level of the soil texture triangle, look at the ribbon formed. If the ribbon is sandy call it a sandy clay, if it is smooth call it a clay. You can do this for any level. Although this system is not as precise as mechanical analysis, it is quite accurate for our purpose.

Soil Map Exercise

PURPOSE--To produce a soil map for your area showing the major types of soils and their texture.

MATERIALS--Teams of five, to be assigned areas to work (materials based on four teams per class)

- 4 soil shovels or 4 soil incurment bores or a combination of both
- 4 acid bottles (dilute Hcl acid)
- many cigar boxes or similar containers
- 1 tape measure
- 20 field data sheets
- 2 geology hammers

2 hand lens
1 map of area section lines forming at least a two-inch square section
one master map of area with two-inch sections

PROCEDURES--Using the map that you have acquired from the Forest Service or Soil Conservation Service, decide what area you want to produce a soil map for. Starting at the lowest point in elevation with is close to you, work up to the highest elevation which is easily reached. The number of the sections you use is up to you and your students, but you should try to include at least one township. However, you may choose to do a more detailed map of one section instead of a township. If a map with larger sections is desired for more detailed work, use the following method. Cut out of a map the area you want to survey, photocopy it in black and make a transparency. You can now expand this to whatever size you want it by putting it on an overhead projector and focusing it on paper and tracing the image. This will give you all the detail of the original map and the proper scale.

After deciding on the area to be used, divide the survey work up according to the number of teams that you have. Each team should have a map of their area to be transferred to the master map at a later time.

In the field a team should decide how large an area is covered by a similar type of soil and mark it on its map as profile 1. The soil profile should then be dug using the shovel or drilled using a bore. After the profile is done the information should be marked on soil profile data sheets similar to the one shown here. Note each horizon, its depth, color and texture, dominant plant cover and the amount of calcium carbonate deposited. After collecting data, place a sample of each soil horizon in a cigar box for future reference. The cigar box should be divided so it will hold at least six horizons. After completely surveying your area you should have a mpa indicating similar areas of soil types numbered and have data sheets for each of these numbered areas. Next you should transfer this information to the master soil map. Before this can be done, however, all teams must come together and find out how many different types of soils have been found and give each a code color. Once the code has been established the individual teams can place their information on the master map. You will now have a map showing all the soil types and their texture, color and depth for the area mapped.

SOIL PROFILE--FIELD DATA SHEET				
HORIZON	Depth in Inches	TEXTURE	COLOR	DOM-INANT SP.
SUGGESTED NAME FOR THIS SOIL IS_____				

INTERPRETATIONS

What are the major soil types in your area?

Is there any pattern to the location of certain soils?

Are there any soil types that occur at more than one elevation? If so, how is this possible?

What is the relationship between color of the soil and the plant life found on the soil?

Is there are relationship between accumulations of materials at a horizon and the plant life found in the soil?

In what ways do you think the texture of the soil might affect water percolation and soil development?

If a soil has few horizons what does this mean?

Is there any evidence that the plant life on a soil might not have been the one which helped form the horizontal development?

ADDITIONAL STUDIES

What was the parent material of the soils that you have studied?

What is the percent of humus in each soil sample?

What is the percent of moisture in each sample?

Is there a relationship between the soil texture and the amount of moisture in your samples?

What is the different rate of percolation of water into the soils and what might be causing these differences?

Make a topography map of this same area.

SUGGESTED SCHEDULE

Monday	Tuesday-Wednesday	Thursday-Friday
Introduce the subject; begin work on mapping	Continue mapping and give the student a number of examples to work.	Begin to study the soils, including horizons and naming of soils.
Review--go over the mapping of soils and the purpose and procedures in the field.	(At this time you may either assign the field work for the students to do on their own or have regular field trips.)	Produce the Master Soil Map. Discuss the results.

REFERENCES:

Alexander, M. Introduction to Soil Microbiology. New York: Wiley, 1964.
Forth, H.D., Jacobs, H.S. Introductory Soil Science. Dubuque, Iowa: Brown Co. 1964.
Miller, C.E., Turk, L.M., Forth, H.D. Fundamentals of Soil Science. New York: Wiley, 1962.
Siuthard, A.R. Soils of Montana. Bulletin 621, Bozeman, Montana: Montana Agriculture Experiment Station, 1969.
Westfall, F. Mapping Deer Lodge, Montana, Powell County High School.

A SURVEY OF A STREAM ECOSYSTEM

Harold F. Fish

11

INTRODUCTION

This working paper can (1) be used in my teaching situation, with my equipment and my schedule and (2) be carried out by most teachers with adequate laboratory facilities with considerable ease. The completion of a project such as this will give the student an appreciation of a part of his environment he takes for granted.

The first part of this paper is an over-view of the entire project primarily for the teacher's benefit. The second part is the student-oriented part and is further divided into separate field studies.

This project will be carried out after the students have been given an introduction to ecology and some conservation practices. This introduction will be in basic ecology principles of food chains, energy flows and population dynamics. A section on soil, water, wildlife and forest conservation will also be reviewed before undertaking the field study.

TEACHER'S INFORMATION

General Objective

To acquaint the student with an "environmental problem" in the local area.

Materials and References

This project can be carried out with the supplies available in the average chemistry-biology laboratory. Some equipment can be made and substitutions can be made for others. Three newer kits on the market today may be of some help:

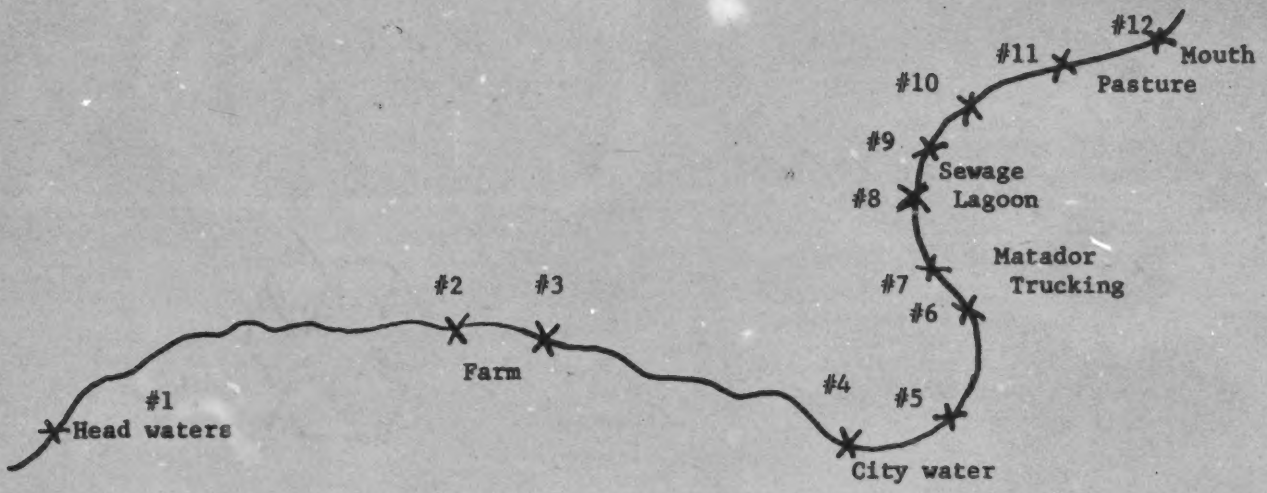
1. Limnology Equipment, Model AM-02 Outfit, LaMotte Chemical Products Company, $94.50

2. Water Pollution Detection Outfit, Model AM-21, LaMotte Chemical Products Company, $99.95

3. Experiments in Environmental Microbiology, Kit XKEM 00100, Millipore Corporation, Bedford, Mass., $48.00

References for the student and the teacher to use as supplementary sources have been listed throughout the teacher and student information sheets.

Survey Area



Objectives, Methods and Technique

Objectives

1. To observe a natural stream ecosystem
2. To determine the natural population within the stream
3. To determine if pollution of the stream is taking place (awareness)
4. To determine the cause and magnitude of any pollution (motivation)
5. To propose corrections if pollution is present (action)

Method

1. Field trip
   a. To a local stream
   b. The class (72 students) will be divided into teams of 12 students (Each class has 24 students)

Survey area--12 areas will be sampled

1. At head waters of Cherry Creek
2. Above Joe Kordonowy farm
3. Below Joe Kordonowy farm
4. Before entering city water system
5. After entering city water system
6. Above Matador Trucking Company
7. Below Matador Trucking Company
8. Above sewage lagoons
9. Below sewage lagoons
10. An area downstream
11. An area further downstream
12. Just above the mouth of Cherry Creek

Analysis at each site

1. Physical factors (temperature, pH, carbon dioxide, oxygen and turbidity)--2 students
2. Bacterial counts--2 students
3. Aquatic microorganisms counts--2 students
4. Aquatic vegetation counts--2 students
5. Aquatic animals counts--2 students
6. Special aspects such as photography, drawings, mappings, etc.--2 students

Distribution of study areas (Of the 12 groups, 2 groups will be combined to study 2 areas)

1. Group A will study areas 1 and 12 - - - - - Section 1
2. Group B will study areas 2 and 3
3. Group C will study areas 4 and 5 - - - - - Section 2
4. Group D will study areas 6 and 7
5. Group E will study areas 8 and 9 - - - - - Section 3
6. Group F will study areas 10 and 11

The purpose of this grouping would allow students to see the ecosystem above and below their survey area.

Work in Class Before Trip

Monday

1. Divide students into areas of their choice (animals, plants, bacteria, physical factors, etc.).
2. Select from these groups the students to make up groups A to F (Select one as a team leader).

Tuesday and Wednesday

1. Research techniques of each job.
   a. How do you determine the physical factors in water?
   b. How do you collect and analyze bacteria?
   c. How do you collect water plants?
   d. How do you collect animals?
   e. How do you determine the topography of the area?
   f. What should the team leader do?

Thursday

Students should make up kits containing the equipment they need. (Bottles, nets, seines, jars, thermometers, etc.)

Friday

Take one day to discuss legal aspects. (Water safety, proper clothing, etc.)

Actual Field Trip
(Probably a Saturday)

Transportation

Two buses would be needed in my area--one taking groups A and B upstream from the school and one taking groups C and D, E and F, downstream. (Group A will have to go downstream sometime during the day also.)

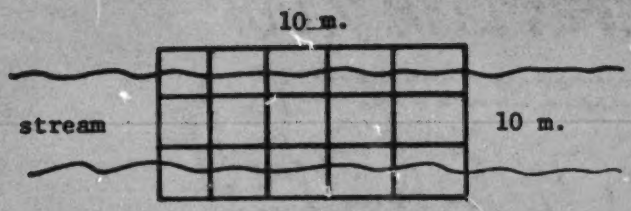
Supervision

Five teachers should be used, one for each group (primarily for insurance reasons and supervision). These could be the life science, earth science and biology, physics and chemistry teachers.

Field Work

After arriving at the upstream site each student in the various groups should begin his assignment.

1. Physical tasks should be done before the stream is disturbed.
2. Plants and animals should be collected from the banks, bottoms, and open water--both floating and attached types.
3. Samples for bacterial analysis should be taken from various places in the stream cross section.
4. Grids should show the location of samples as well as numbers.



5. Alternative ideas
   a. Gill or Fyke nets could be placed in the stream the night before.
   b. Live animal traps could be placed along the stream bank (for frogs, muskrats, birds, etc.)

Work in Class After Trip

Saturday afternoon and for at least one week following trip

1. Plants should be preserved after identification and proper labeling. Identification can be obtained from the following sources:
   a. How to Know the Trees, Jacques, 1946
   b. Plant Families--How to Know Them, Jacques, 1948
   c. How to Know the Mosses and Liverworts, Conrad, 1944, 1956
   d. How to Know the Fall Flowers, Cuthbert, 1948
   e. How to Know the Grasses, Pohl, 1953
   f. How to Know the Fresh-Water Algae, Prescott, 1954
   g. How to Know the Western Trees, Baerg, 1955
   h. How to Know the Weeds, Jacques, 1959
   i. Handbook of North Dakota Plants, O. A. Stevens, 1963
   j. Taxonomy of Flowering Plants, C. L. Porter, 1959
   k. Trees and Shrubs for the Northern Plains, Donald G. Hoag, 1965

   Preservation information can be obtained from the following sources:
   a. Taxonomy of Flowering Plants, C. L. Porter, 1959
   b. A Sourcebook for the Biological Sciences, Harcourt, Brace and World, 2nd Edition, 1966
   c. Any of the How to Know series

2. Animals that are taken alive should be recorded and released unless there are indications that they are ill and good specimens for analysis. (Why are they ill? Find out.) What do you do with them then? Numbers of genera and species should be recorded. References for identification are as follows:
   a. How to Know the Insects, Jacques, 1947
   b. Living Things--How to Know Them, Jacques, 1946
   c. How to Know the Land Birds, Jacques, 1947
   d. How to Know the Immature Insects, Chu, 1949
   e. How to Know the Protozoa, Jahn, 1949
   f. How to Know the Mammals, Booth, 1949
   g. How to Know the Beetles, Jacques, 1951
   h. How to Know the Spiders, Kaston, 1952
   i. How to Know the Freshwater Fishes, Eddy, 1957
   j. How to Know the Water Birds, Jacques--Gilivier, 1960
   k. How to Know the Butterflies, Ehrlich, 1961
   l. How to Know the Grasshoppers, Helfer, 1963

   Preservation information can be obtained from A Sourcebook for the Biological Sciences, Harcourt, Brace and World, 2nd Edition, 1966, pp. 545-569.

3. Oxygen and carbon dioxide analysis should be completed in the laboratory as soon as possible. Turbidity analysis and pH can be started and finished the next week in lab. Temperature has already been determined in the field. Let these students have about a week to complete their analysis and summaries.

References are listed on student information sheets.

4. Bacterial analysis should be started Saturday afternoon so that the count will remain relatively unchanged from the original. This will take about a week to complete because of the incubation periods.

References are listed on student information sheets.

5. Analysis of the water for microorganisms should also be started to eliminate succession. Students can continue their section throughout the following week.

References are listed on student information sheets.

Monday thru Friday of week following trip

1. Continue as directed in 1-5 above.

2. All group leaders should meet with their groups to analyze their progress.

3. After each team has completed their reports
   a. they should be relayed to the rest of their class, in a way of oral presentation using large charts, pictures, transparencies, etc.
   b. they should be combined with the results of the other five groups into a complete report on the ecosystem.

Related Projects and Benefits

Other Related Projects

1. Survey a small lake or pond.
2. Survey a grassland ecosystem.
3. Take field trips to
   a. wildlife refuges
   b. mining operations (strip mining if possible)
   c. electric plants
   d. fish hatcheries
   e. national and state parks
   f. water treatment plants
   g. land fills
   h. various industries

Other Benefits from Such Projects (Not necessarily in order of importance)

1. How to use taxonomy keys
2. How to be precise
3. How to use microscopes
4. What kinds of organisms live around us?
5. What kinds of organisms are affected by pollution?
6. How does pollution affect us?

7. An introduction to chemistry
8. An appreciation of our surroundings
9. To help make the students more observant

STUDENT'S INSTRUCTIONS

Introduction

We are going to study a section of Cherry Creek for the purpose of:

1. observing a stream ecosystem
2. becoming aware of the interrelationships that take place in the stream
3. determining if man has altered the natural ecosystem in any way (Is he polluting it?)
4. determining to what extent man has altered the ecosystem.

General Information

You, the student, will be doing much of the analysis of this ecosystem. I will make materials, references and myself available, but it will be up to you to decide how to make your observations, how to record your results and how to relay them back to the class.

Approximately two weeks of class time will be designated for this study. Between the two weeks we will have a Saturday field trip. (It is very important that you make arrangements to attend this trip.)

Each section of biology will be divided in half. Each group is responsible for its area and by combining the information from each group we can see what the entire stream is like.

With my help you should select an area of study that interests you, such as animal life, plant life, bacteria, physical factors, photography and art. You will then be placed in a group to do a certain job. After you are in your groups, select a team leader. (Preferably someone who can be available at all times and who lives in town.)

After you have selected your topic of discovery and are in your groups you may ask yourself these questions:

1. What materials do I need for my job?
2. What procedures do I use?
3. What should I be on the lookout for?
4. How do I interpret my results?
5. What should I do when I'm finished?

The answers to most of these questions are found on your instruction sheets for the various jobs. Remember you are responsible for researching your area. Find out what you need and how to use it.

Team and Project Leader's Responsibilities

Team Leader's Responsibilities

1. It is your responsibility to see that everyone on your team does his job to the best of his ability.
2. It is your responsibility to see that all equipment is ready before going into the field.
3. It is your responsibility to see that all equipment is cleaned and put away after this project is completed.

4. It is your responsibility to gather all data from your team members and compile a short summary including charts, graphs, maps, pictures, etc.
5. It is your responsibility to work with the project leader and work your group report up into an overall project report.

Project Leader's Responsibilities

1. It is your responsibility to oversee this entire project.
2. It is your responsibility to give aid to any group or individual that needs it.
3. It is your responsibility to, with the six group leaders, put together a final report on this project.

ANALYSIS OF THE STREAM FOR ITS PHYSICAL FACTORS

(Temperature, oxygen content, carbon dioxide content, pH and turbidity)

This study is actually five separate projects. Do each one, one at a time in the order they appear here. Be very accurate as they are very important. Answer the questions to each project. Organize your data on one chart or graph so it can be interpreted easily. Give the graph to your team leader when you have finished.

Measurement of Turbidity in Aquatic Ecosystems

Purpose: To determine the amount of silt in Cherry Creek

Materials: Filter paper, quart jars, ring stand and funnels

Procedure: In the field: Collect 4 1-quart samples of water from approximately the same place you got your samples for the other physical factors. (One along shore and one in open running water.) Seal and label the jars until you get back to the laboratory. (Collect two samples from each area and analyze one from each area and save one for demonstration.)

In the laboratory: Weigh a piece of filter paper for each sample and mark each with a sample number. Record the weight of each filter paper. Set a funnel on a ring stand and line it with the filter paper. Filter the first quart sample. Mud, silt and other residue will collect in the filter paper. Repeat for all samples. Then dry the papers and residue until Monday. Weigh the dried filter paper and residue and record the weight for each sample. By subtracting the original weight of the paper, you can determine the exact weight of the sediment in one quart of water. Calculate the sediment in one gallon of water for each sample.

Summary

1. What was the weight of sediment in each sample?
   Shoreline equals_____per gallon
   Open water equals_____per gallon
2. What was the color of the water in each case?
   Shoreline_____
   Open Water_____
3. Describe the watershed_____
   _____

Measurement of pH in Aquatic Ecosystems

Purpose: To determine the pH of Cherry Creek

References:

1. Our Environment Battles Water Pollution by Charles Renn
2. Limnology: An Introduction to the Fresh Water Environment by William Amos
3. pH, Buffers and Acid Base Titrations by Staff of LaMotte Chemical Products Co.
4. BSCS Green Version, Student's Manual, Rand McNally, 1963, pp. 181-184

Materials: Glass marking crayon, glass stirring rods (1 per sample), microscope slides (1 per sample), widerange pH test paper (1 cm. per sample). wide mouth jars (1 per sample, ½ pint)

Procedure: In the field: Obtain samples of water from within the study area. One should be along the shore line and one from open running water. These may be put in wide mouth jars, sealed and labeled until you return to the laboratory.

In the laboratory: Put the jars of water on your table and place a microscope slide in front of each jar. Label the slide to go along with the jar of water behind it. Place a small piece of test paper on the slide. Dip a glass stirring rod into the water and transfer a drop of liquid to the test paper. Repeat if not enough liquid was obtained. Note the color of the test paper where the drop has been placed, and compare it with the color scale that comes with the paper. Record the pH of the sample. Repeat this procedure for each sample using a different stirring rod and slide for each sample.

Summary: (pH 1 to 6 -- acid, 7 -- neutral, 8 to 14 -- alkaline)

1. What is the pH range discovered in your samples?
   _____ and _____

2. According to your evidence, is the stream more acid or alkaline?_____

3. Can you think of any reason for this? _____
   If so, state it _____
   _____

Measurement of Temperature in an Aquatic Ecosystem

Purpose: To determine the temperature of Cherry Creek

References:

1. Our Environment Battles Water Pollution by Charles Renn
2. Limnology: An Introduction to the Fresh Water Environment by William Amos

Materials: Thermometer

Procedure: Take several readings along the shoreline within the study area. Average them out and record the results.

Take several readings in more open water. Average these out and record the results.

Summary:

1. What was the average temperature along shore? _____
2. What was the average temperature in open water? _____
3. If there was a difference, why? _____

Measurement of Dissolved Oxygen in Aquatic Ecosystems

Purpose: To determine the dissolved oxygen content in Cherry Creek

References:

1. A Sourcebook for the Biological Sciences: Harcourt, Brace and World; pp. 22-25; (1st Edition)
2. Our Environment Battles Water Pollution by Charles Renn
3. Limnology: An Introduction to the Fresh Water Environment by William Amos
4. Modern Chemistry, by Metcalfe, 1966, Chapter 14

Materials: Manganous sulfate (400 grams), Sodium hydroxide (500 grams), Potassium iodide (150 grams), Undiluted Sulfuric acid (.5 ml.), Sodium thiosulfate (3.1 grams), Cornstarch (1 tablespoon), Burrette apparatus, collecting bottles

Procedure: In the laboratory: Several solutions are necessary for this experiment. You should make these up in advance before going into the field.

1. Manganous sulfate: add 400 grams of $MnSO_4.2H_2O$ to 1 liter of water.
2. Potassium hydroxide--potassium iodide: add 500 grams of sodium hydroxide to 1 liter of water; then add 150 grams of potassium iodide.
3. Sodium thiosulfate: add 3.1 grams of sodium thiosulfate to 1 liter of water.
4. Starch suspension: Boil 1 tablespoon of cornstarch in a cup of water.

In the field: Collect two 100 ml. samples of water from approximately the same place as you collected water for your pH tests (along shore and open running water). You can do this experiment at the survey site but it will take some time. Avoid agitating the water while collecting it. Several chemical reactions are involved in this rather long procedure. (Take your time, your information may be very important.)

Steps:

1. To the 100 ml. sample of water add .5 j.. of solution of manganous sulfate.
2. Add 1.5 ml. of a mixture of potassium hydroxide-potassium iodide solution.
3. Shake the sample with the test solutions.
4. Add .5 ml. of undiluted sulfuric acid (be very careful). A brown precipitate forms in the solution. Let stand for 5-10 minutes.
5. Add a few drops of starch suspension to your sample so that a blue-black color results.
6. Titrate your sample with sodium thiosulfate until the sample turns colorless. (Review reference: Modern Chemistry, Chapter 14)

The number of milliliters of thiosulfate needed to turn the sample colorless is equal to the parts per million (p.p.m.) or oxygen dissolved in your sample.

Repeat the same procedure for your second sample.

Summary:

1. What was the oxygen content in p.p.m. along the shore line? _____
2. What was it in open water? _____
3. Can you account for the difference? _____
   Explain _____

Measurement of Dissolved Carbon Dioxide in Aquatic Ecosystems

Purpose: To determine the dissolved carbon dioxide content in Cherry Creek

References:

1. A Sourcebook for the Biological Sciences. Harcourt, Brace and World, pp. 268-269 (2nd Edition)
2. Limnological Methods by Paul S. Welch 1948, pp. 213-214

Materials: Phenophthalein powder (1 gram), ethyl alcohol (40 ml.), sodium hydroxide (.4 grams), burette apparatus, collecting bottles

Procedure: In the laboratory: The following solution is necessary for this experiment. Make up before going into the field.

Phenolphthalein indicator: Add 1 gram of phenolphthalein powder to 40 ml. of ethyl alcohol; add this to 120 ml. of distilled water. Now add a few drops of .04% sodium hydroxide (.4 grams to 1,000 ml. of water) until a rose color appears and persists.

In the field: Collect two 100 ml. samples of water from approximately the same place you collected water for your pH tests. (Along shore and open running water.) You can do this experiment at the survey site but it will take some time. Avoid agitating the water while collecting it.

Steps:

1. To the 100 ml. sample of water add 5 drops of phenolphthalein indicator
2. From a burette add, drop by drop, the .04% sodium hydroxide, until a pink color appears.
3. Carefully add 1 drop at a time to reach the end point where the pink color remains.
4. Record the number of milliliters (in tenths) of sodium hydroxide used to reach this end point.
5. The dissolved carbon dioxide in the water is equal to 10 times the number of milliliters of sodium hydroxide used. It is expressed in parts per million (p.p.m.).

Summary:

1. Was the carbon dioxide count the same for both samples? _____
2. What was the count for the carbon dioxide along the shore area? _____p.p.m. in the open water? _____p.p.m.
3. Can you account for any difference? _____

MAKING A SURVEY OF ANIMALS IN A STREAM ECOSYSTEM

Purpose:

1. To acquaint you with the diversity of life in a stream

2. To determine population densities in the sample area
3. To determine tolerant and intolerant species

References:

1. BSCS Green Version, Student's Manual Rand McNally 1963, pp. 155-170, esp. pp. 166-168.
2. Guide to the Study of Freshwater Biology, P. Needham, 1962
3. How to Know the Freshwater Fishes, S. Eddy, 1957.
4. Field Guide to Reptiles and Amphibians, R. Conant, 1958
5. Life of Inland Water, Needham and Lloyd, 1916
6. Limnological Methods, Paul S. Welch, 1948
7. Sourcebook for the Biological Sciences, Harcourt, Brace and World, (2nd Edition)

Materials: Dip net (for frogs, fish, turtles), 2 seines, 1 net for fish, 1 window screen (approximately 2 feet by 3 feet), wide mouth jars--6, assorted sizes up to 1 gallon (one, 1 qt. for sure), 1 nylon stocking

Procedure: In the Field: Animals should be collected from various places within the sample area. Try to obtain specimens from along the shore, open running water, on the surface of the water, and on the bottom of the stream.

From your reference reading you can get some good techniques of collecting. Be sure to examine plants in the water for animals also.

Collecting: Along the Stream: You can collect along the shore line with either a dip net or a seine made of window screen. Try to catch large organisms as well as the small ones. Animals like frogs and turtles can be captured and counted and then released some distance from our study area. Several of each should be kept for classification and preserved for the museum. To use the screen, hold it in the water and have your partner turn over rocks and debris in the water above you. Insect larva, etc., will float down stream and cling to the screen. As you are collecting this way place a closed quart jar in front of your screen in the water. After agitating the water, open the jar and let it fill up. Do this 5 times in the sample area. After filling up the jar each time pour the water through a nylon stocking. Any organisms in the water will be trapped in the stocking. The stocking with its contents can be put in a jar of pond water for further study. By counting the number of organisms and dividing by five you can determine the number per quart of water in that area. If you want only microorganisms, take a 1 ml. sample of water from a quart jar, count the microorganisms in the 1 ml. and multiply by 1,000. This will give you the approximate number per quart of water. They can then be placed in a jar of pond water for further study. Study a total of 10 meters of shore line.

Collecting: In the Open Water: Use a seine for collecting in the open stream. With a person on each end, move up the stream for a distance of 10 meters. Have two of three other people up stream from you (within the 10 meter sector) making noise, splashing, etc. This is so the fish will not go up stream and escape. Put whatever you catch in collecting jars for later study. (Count and release any frogs, turtles, etc., you don't need.)

Collecting: On Shore: Keep count of large animals seen in the area (birds, rabbits, antelope, muskrats, etc.).

In the laboratory: Most of the animals you have seen or captured are large enough to see with the unaided eye. They should be separated by location and types (classified), counted, labeled and put away for later reference. Use 70% alcohol for preserving the smaller organisms but see pp. 560-563 in reference No. 7 for more specific preservatives.

Summary:

1. Did you collect more small or large organisms? _____
2. Account for this. _____
3. Where did the majority of your specimens come from? (Shoreline or open water.) _____

Make a bar graph that will indicate the number of each individual collected. (Give genus and species names.) Be sure to show those you observed on shore. Give this graph to your team leader.

MAKING A SURVEY OF PLANTS IN A STREAM ECOSTSTEM

Purpose:

1. To acquaint you with the diversity of life in a stream.
2. To determine population densities in the sample area.
3. To determine tolerant and intolerant species.

References:

1. BSCS Green Version, Student's Manual, Rand McNally 1963, pp. 155-170 esp. 164-165 (2nd Edition)
2. Aquatic Plants of the U.S., W. Muenscher, 1944.
3. Guide to the Study of Freshwater Biology, P. Needham, 1962
4. Life of Inland Water, Needham and Lloyd, 1916
5. Limnological Methods, Paul S. Welch, 1948
6. Sourcebook for the Biological Sciences, Harcourt, Brace and World, (2nd Edition)

Materials: Shovel or trowels, plastic bags--1 dozen, dip net (small mesh), plant press

Procedure: In the field: Be very observant of the survey area. Many of the plants cannot be taken back because of their size and numbers. You should collect a few samples of these for demonstration purposes and proper identification. Where at all possible try to determine the number of each. This can be done by measuring a square yard plot and counting the number in that area. Then determine the area of the stream in which these plants are growing. If that area is 15 square yards, multiply the number you found in one square yard by 15 to determine the total number of plants of that species.

Repeat this method for all plants in the area. Be sure to look in the water for plants growing also. Collect some of these and record their numbers. Someone in your group is doing a study of small floating plants so it is unnecessary for you to do this.

In the laboratory: After you have returned to the laboratory your plants may be left in plastic bags with a little water in them in the refrigerator or just in the refrigerator if they are too big for sacks. When you have time, the plants should be identified by using plant keys (see reference).

Summary:

1. What was the most common plant type on the shore line? _____

What was the least common? _____

2. What was the most abundant in the open stream? _____
   What was the least common? _____

Make a bar graph showing the approximate numbers of each species you found. Give this graph to your team leader.

Work with the person in charge of mapping the area on a map that shows the approximate distribution of the vegetation in that area.

MAKING A SURVEY OF MICROORGANISMS AND MACROORGANISMS (EXCEPT BACTERIA) IN A STREAM ECOSYSTEM

Purpose:

1. To acquaint you with the diversity of life in a stream
2. To determine population densities in the sample area
3. To determine the tolerant and intolerant species

References:

1. BSCS Green Version, Student's Manual, Rand McNally, 1963, pp. 30-35
2. How to Know the Protozoa, T. L. Jahn, 1950
3. Guide to the Study of Freshwater Biology, P. Needham, 1962
4. Freshwater Invertebrates of the U.S., R. W. Pennak, 1953
5. Life of Inland Water, Needham and Lloyd, 1916
6. Limnological Methods, Paul S. Welch, 1948
7. Sourcebook for the Biological Sciences, Harcourt, Brace and World (2nd Edition)
8. How to Know the Aquatic Plants, G. W. Prescott, 1969

Materials: Plankton net (you have to make this. See procedure), collecting jars, various sizes

Procedure: In the laboratory: To make a plankton net, you need a nylon stocking and a clothes hanger. Round out the clothes hanger and stretch the stocking so it will fit around the hanger. You may want to cut the hanger so it has a smaller circumference. Sew the stocking securely to the hanger. Cut the foot part off the stocking and insert a wide mouth bottle, using a rubber band to hold it on, point B.

Attach 4 pieces of twine (each about 2 feet long) to the hanger and join these together, as shown in illustration at point A. Attach another piece of twine to this, with which you can pull your net through the water.

In the field: You will be working very closely with two other groups. They are doing a survey of animals and surveying plants. When you finish your analysis, your data will be incorporated into theirs.

Lay your net in the water along the shore and pull it up stream to the end of the study area. When you have gotten to the other end, remove the collecting jar, stopper it, label it and set it aside for later study. Put a new bottle on and repeat the process but this time go from the downstream end of the study area to the upper most end several feet from shore. Remove jar, stopper it and label. Repeat this procedure on each of the following areas:

1. Shore line (surface)
2. Shore line (bottom, if possible)
3. Middle of stream (surface)
4. Middle of stream (bottom)--Don't worry about getting some rocks in your jar. Be sure to clean out the stocking thoroughly before taking each collecting jar off. Once you have removed the jar the stocking can be turned inside out and waved in the breeze to get any other organisms out.

In the laboratory: Keep specimens taken from each part of the survey area separate. By using a piece of nylon stocking strain the contents of each jar. This will concentrate them more. Place the contents into a petri dish and add a small amount of 10% formalin. This kells the organisms. Note: If you have time for more work today (Saturday afternoon) add water instead of formalin so you can view the organisms alive. By using the key that is attached try to separate the organisms into different groups. (This will take some time.) As you separate them, put the very small ones into another petri dish with a small amount of formalin in the bottom (just enough to cover the specimens). These can then be counted on the bacteria colony counter. (Review its use.) The larger specimens can be put into jars of formalin, counted and labeled for later reference.

Summary:

1. Did you collect more small or large organisms? _____
2. Account for this. _____
3. Where did the majority of your specimens come from? (Shore line or open water) _____

Make a chart that will indicate the number of each individual collected. Use chart in Modern Biology Laboratory Manual as a guide, P. 166. Give this chart to your team leader.

BACTERIOLOGICAL ANALYSIS OF WATER IN A NATURAL ECOSYSTEM

Purpose: To determine the bacterial content and possible presence of coliform organisms in Cherry Creek.

References:

1. Modern Biology Laboratory Manual, 1969
2. A Sourcebook for the Biological Sciences, Harcourt, Brace and World, (2nd Edition)

Materials: Wide-mouth bottles with ground glass stoppers or caps, 4--8 oz. (for collecting water samples); Petri dishes (seven per sample); dilution bottles (six per sample); 1 ml. pipettes (seven per sample); 11 ml. pipettes (six per sample); pipette containers; 6--in. culture tubes and APHA 1 15/16 inch tubes for preparing fermentation tubes (five per sample); tube rack or basket; cotton for plugs; inoculating needle, autoclave or pressure cooker; hot-air oven; ring stand, funnel, rubber tube and tubing clamp (for filling fermentation tubes); colony counter; nutrient agar (150 ml. per sample); eosin methylene blue agar or Endo agar plates (for coliform test); lactose broth.

Procedure: In the laboratory: "Preparation of media." Prepare the nutrient agar as directed in Investigation 16-2, Modern Biology Laboratory Manual, sterilize in media bottles and store in the refrigerator until used.

Prepare sufficient eosin methylene blue agar or Endo agar to allow about 100 ml. for possible use for each sample. After sterilization, this media may be stored in bottles or poured into sterile petri dishes (15-20 ml. per dish). Refrigerate this medium until used. Prepare lactose broth according to the directions on the bottle (50 ml. per water sample to be tested). After dissolving the lactose broth in distilled water, pour the broth into a funnel equipped with a rubber delivery tube and clamp, supported on a ring stand. To prepare a fermentation tube, drop an APHA 1 15/16 inch culture tube, open end down, into a 6--in. culture tube. Fill each fermentation tube half full of lactose broth. Plug with cotton and place in a tube rack or basket for sterilizing. Prepare five lactose broth fermentation tubes for each water sample. Sterilize the fermentation tubes in an autoclave or pressure cooker at 15 pounds for 15 minutes. Air should be forced out of the small tubes during sterilization and cooling.

Prepare and sterilize the dilution bottles, pipettes, and petri dishes as directed in Investigation 16-5, Modern Biology Laboratory Manual. The ground glass stopper or screw-can bottles for collecting water samples may be boiled for 10 minutes or sterilized in an autoclave or pressure cooker.

In the field: Collect water from three places in the survey area. Be sure to label each of your samples. This is the only field work involved in the experiment.

In the laboratory: Liquify nutrient agar for pouring plates as directed in Investigation 16-2, Modern Biology Laboratory Manual. Mark seven petri dishes for each sample, indicating the sample number, dilution factor (0 through 1:1,000,000) and date. Mark six dilution bottles with dilution factors 1:10 through 1:1,000,000 for each sample. Place five lactose broth fermentation tubes in a row in a tube rack for each sample. Each set of five tubes need be identified only by sample number and date.

Using a sterile 1 ml. pipette, transfer 1 ml. of water from sample 1 to each of five lactose broth fermentation tubes and to the 0 dilution plate. Continue the dilution series and 1 ml. plate inoculations through the 1:1,000,000 dilution. Repeat the procedure for all other samples, inoculating five lactose broth fermentation tubes for each sample and preparing a set of seven plates from the dilution series. Pour all plates with nutrient agar at 45°C, diffuse the inoculum into the media by agitating the plate, and allow to gel. Incubate the lactose broth tubes and plates at 35-37°C.

After 24 hours, examine the lactose broth fermentation tubes. If gas is present in the small tube (the tube may float to the surface) mark a plus (+) in the appropriate column of the table. If no gas is present, mark a minus (-).

The formation of gas in lactose broth in 24 hours is considered a positive presumptive test for coliform organisms. A second test is used for each tube showing gas. Liquify eosin methylene blue agar or Endo agar and pour about 20 ml. into sterile petri dishes for streaking (one for each positive broth fermentation tube). Identify the plates by sample number corresponding to the fermentation tubes. Using an inoculating needle, streak an eosin methylene blue agar or Endo agar plate with each positive tube. Return the negative lactose broth fermentation tubes and streaked eosin methylene blue agar or Endo agar plates to the incubator. After streaking, you may discard the positive lactose broth tubes.

After a second 24-hour incubation period, remove all plates and tubes from the incubator. Count as many plates as you can in the dilution series with a colony counter and record the counts in the table. Indicate plates with colonies too numerous to count as TNTC. Calculate the bacteria count per ml. of water from a plate showing 30-300 colonies, if possible. Record this count in the table.

Examine the remaining lactose broth fermentation tubes. Record them as positive (+) or negative (-) after 48 hours. The production of gas within 48 hours but not within 24 hours is considered a doubtful presumptive coliform test. However, these tubes should be streaked on eosin methylene blue agar or Endo agar, incubated and examined after 24 hours.

Examine the eosin methylene blue agar or Endo agar plates streaked from fermentation tubes showing gas in 24 hours. Characteristics of the growth on these differential media are used to distinguish coliform bacteria (Escherichia coli) from organisms of nonfecal or intestinal origin which ferment lactose. Escherichia coli forms a growth with a flat surface and a greenish metallic sheen on eosin methylene blue agar. On the other hand, noncoliform lactose fermenters (including Aerobacter aerogenes) form a light pink, mucoid (slimy) growth. The growth of Escherichia coli on Endo agar is deep red, with red coloration of the surrounding media. Noncoliform organisms form a pink, mucoid growth on Endo agar. Indicate plates with coliform organisms as positive (+) for the confirming test in the table and those with non-coliform organisms as negative (-).

In some cases, certain coliform organisms fail to develop characteristic colonies on eosin methylene blue agar or Endo agar, or may form typical colonies. For this reason, a negative confirming test for coliform organisms cannot be considered conclusive proof of the absence of coliform organisms in water. A further and more complicated completed test may be used. This test is outlined in Standard Methods for Water and Sewage Analysis and in many bacteriology books.

Summary:

1. Report your coliform analysis as the number of plates that were positive in the confirming test on eosin methylene blue agar or Endo agar._____
2. Using the data summarized in your table, discuss each sample as safe or unsafe to drink and the reasons for your decision. If possible, account for the plate counts in each sample and for the presence or absence of coliform organisms._____

BACTERIA COUNT		COLIFORM ANALYSIS		
DILUTION	COLONY COUNT	PRESUMPTIVE TEST		CONFIRMING TEST
0		Lactose 24 hours	Lactose 48 hours	EMB or Endo agar 24 hours
1:10				
1:100				
1:1,000				
1:10,000				
1:100,000				
1:1,000,000				
Bacteria count/ml _____		Coliform analysis _____		

When complete, give this chart to your group leader.

CONCLUSION

After the entire report has been completed and the students can see what they were a part of, the awareness aspect of the objectives will probably have been fulfilled. The students will probably realize that the stream is in some way polluted.

Through class discussions the students should become motivated enough to do something about the situation. The degree of action will depend largely on the student's attitudes. They could start by asking the parties involved in polluting the stream to try to clean it up. With their project summary as a guide they will have some good "ammunition" to work with.

Possibly through a project such as this, the student will be motivated enough to question other practices in the area. These may include the local dumps, the use of pesticides by farmers, back yard burning, degradation of wildlife habitat, etc.

AIR AND WATER POLLUTION STUDY

Sister Catherine Shields

12

ONE SEQUENCE OF TOPICS FOR A SCIENCE UNIT ON AIR POLLUTION

I. Introduction to study of air pollution
   A. Defining "What is Air Pollution?"
   B. Past history of air pollution
   C. Present day problem of air pollution

II. Factors producing objectionable contamination
   A. Impurities in the atmosphere
      1. Gases (nitrogen oxides, ozone, sulfur oxides, organic chemicals, etc.)
      2. Aerosols (smoke, fumes, dust, mists, odors, etc.)
   B. Insufficient air movement
      1. Horizontal dispersion of contaminants by wind--effectiveness?
      2. Vertical dispersion of contaminants by thermal changes--effectiveness?
      3. Dispersion by man-made devices--effectiveness?

III. Weather modification and its effect on life
   A. Warming trend due to release of CO_2 through burning of fossil fuels
   B. Photochemical effect
   C. Thermal inversions
   D. Organism deterioration due to climatic changes

IV. Biological effects of air pollution
   A. Deaths of human beings
      1. Belgium Meuse Valley, 1930
      2. Donora, Pennsylvania, 1948
      3. New York City, 1953, 1962, 1966
   B. Non-infectious diseases
      1. Cardiovascular diseases, stroke, cancer, chronic pulmonary disease
   C. Irritating disabilities
      1. Sore throat, eye irritation, headache, nausea
   D. Mutagenic properties of radioactive contaminants

V. Case Studies
   A. Readings from current sources of reliable information
   B. Field trips
      1. Local industries
      2. Pollution control agency
      3. Citizen groups
   C. Environmental analysis
      1. Local geography of the area
      2. Meterological situation
      3. Industrial conditions
      4. Existing control systems

VI. Legal and action-oriented procedures

A. Legal informational knowledge
   1. Federal Air Quality Act of 1967 (Public Law 90-148)
      a. Section 107--Air Quality Control Regions, Criteria and Control Techniques
      b. Section 108--Air Quality Standards and Abatement of Air Pollution
B. Action-oriented procedures
   1. Join with and help establish local citizen action groups
   2. Form study groups to look into environmental problems of local interest
   3. Produce videotapes and tape recording-slides presentations for use in other schools, etc.
   4. Campaign actively for elective officials who hold sound positions on environmental issues.
   5. Promote legislation for environmental enforcement of standards
   6. Write to congressmen urging them to support environmental legislation

ONE SEQUENCE OF TOPICS FOR A SCIENCE UNIT ON WATER POLLUTION

I. Plants and Animals
   A. Normal environments
      1. Still water residents
      2. Rapid water residents
   B. Polluted environments
      1. Still water residents
      2. Rapid water residents
II. Physical factors in aquatic environments
   A. Temperature
      1. Effect on density--overturn
      2. Effect on solubility of gases dissolved in water
      3. Effect on metabolism of organisms
      4. Sources of thermal pollution
         a. Industrial wastes
         b. Electric Power Companies
   B. Mineral concentration
      1. As limiting factor in algae growth
      2. As pollutants which disturb #1
   C. Dissolved oxygen
      1. Factors influencing O_2 content
      2. Aerobic effects vs. anaerobic effects
   D. Others
      1. Immiscible liquids as oils, dyes and organics
III. Ecology of aquatic environments
   A. Fresh water
   B. Salt water
IV. Case studies
   A. Readings from current sources of reliable information
   B. Field trips
      1. State fish and game department
      2. Electric power plant
      3. Local polluted areas
   C. Environmental analysis
      1. Algae study
      2. Coliform bacteria study
V. Waste Treatment

A. Primary treatment technology and biology
B. Secondary treatment technology and biology
C. Home septic treatment
D. Conditions of A, B and C on a typical watershed

VI. Legal and action-oriented procedures and alternatives to pollution
A. Reporting of pollution-law violators
B. Filing of environmental lawsuits
C. Active campaigning for elective officials who have sound positions on environmental issues
D. Promoting of legislation

GROUP DISCUSSION SESSIONS USING AUDIO-VISUAL APPROACH

Group discussions on film, slides or tapes could be used for one class per week. Films etc. should be selected carefully and present, not only the deplorable condition of environmental degradation, but also the positive ways of solving the actual problems. See Environmental Film Listing for possible films.

Possible Outgrowth from Film Approach:

Encourage students to produce their own films or slides picturing specific examples of local polluted areas or areas people are cleaning up. Professional films, viewed the first two weeks or so, could serve as a springboard for ideas of demonstrating effective filming techniques. Small groups interested in specific topics on pollution (e.g., air, water, industrial, automotive, etc.) could then research information and correlate verifiable statistics and accurate data with the films or slides to reinforce the fact that pollution is a real problem "at home." As students begin to get their own slides, effective group discussions could be led by the students themselves. Greater enthusiasm could be stimulated if the students could prepare a symposium for the school, parents or city whereby their efforts would result in an action-oriented project.

Equipment Needed:
16mm projector
8mm or super 8mm projector
Slide projector

Cameras:
Many students have film cartridge cameras which take fine pictures and eliminate the need for light adjustment techniques especially confusing for beginners.

Movie cameras with a zoom lens apparatus are especially effective for film making. Electric eye focusing eliminates many problems for the beginner.

Film:
Use of super 8 film rather than regular 8mm film will give bigger and brighter films.

Cartridge film is easily available and prevents the possibility of exposing the film when loading and unloading the camera.

STUDENT INFORMATION SHEET FOR POLLUTION STUDY

I. Scientific Communication:
A sample outline is suggested here for writing an account of laboratory work.

1. Title
2. Materials and Equipment
3. Experimental Design
4. Data - may be in the form of tables or graphs
5. Discussion - analysis and interpretation of data
6. Conclusions - a summary

Accurate record-keeping is one of the most important phases of your work. It is imperative that records be made at the time of observation in a permanent data book. Include the date and time of each observation.

Graphs of quantitative data are important in scientific communication. Use them whenever you can, and, when you are graphing results, take pains to plot points accurately and to connect them with smooth lines. Label the quantities plotted on the vertical axis (ordinate) and horizontal axis (abscissa) and give the entire graph a concise title.

II. Experimental Design for Independent Study Labs

1. Restrict your investigation to a single problem.
2. Gather as much information as possible.
3. Use as many replicates as possible.
4. Obtain the most precise measurements possible.
5. Have adequate controls.
6. Make the investigation as simple as possible.
7. Evaluate the design of the investigation as it is performed.

III. Simple Rules for Field Trips

The following simple rules are suggested for all field work study. The opportunity to study living organisms in their natural environments and to see the broad picture of the interrelationships of a physical environment with its microorganisms, plants and animals should be very beneficial for your ecological studies.

1. Be sure you know your federal and local game laws before collecting fish, birds or mammals.
2. Seek permission before invading private property.
3. Avoid collecting or disturbing eggs, young animals or nests of birds or other animals.
4. Replace rocks, wood or any litter that has been disturbed, since these serve as a blanket and moisture-holder for many kinds of living things. When a log has been rolled over in search of specimens, roll it back to its original position when you are finished. Save lives, no matter how small.
5. Keep the destruction of tree branches or entire plants to a minimum and do not litter or deface the area in which you are working.

SUGGESTED LABORATORY ACTIVITIES FOR ENVIRONMENTAL STUDY OF POLLUTION

A study of algae for the detection of polluted water areas would be the major focus for this study. This choice was based on the following considerations: 1) algae are relatively harmless to man, 2) algae are fairly large and are easily seen through the microscope without the need for staining, 3) algae can be stored and cultured in the laboratory and 4) aquaria containing algae could be easily maintained throughout the course.

Students would study the algae in both the natural and artificial environment and become involved in investigative research, relating lab studies with

independent work projects. Previously stocked aquaria would have various algae which the students would study for basic orientation practice. Then groups would begin collecting samples from various areas for their particular study.

Each student would be expected to become fairly knowledgeable in one of the topics geared for independent study, and small goups could pool resources and present their findings to the class for discussion and criticism. Experiments of a comparative nature would be the most common type. Individuals could set up their own experimental design.

The study would take several weeks and probably individual studies would extend over a greater period of time. As long as the interest lasts, students should be allowed to work and present data to the group.

Schema: Algal Study in Water Supplies as an Indication of Pollution Contamination

I. Introductory orientation
   - A. Algae ecology in a fresh-water habitat, ecological conditions
     1. Biological
     2. Chemical
     3. Physical
   - B. Algae physiology
     1. Nutrition
     2. Photosynthesis
     3. Respiration
   - C. Algae economic importance
     1. Credit (food, commercial products, medicine, etc.)
     2. Debit (water spoilage, animal and fish deaths, etc.)

II. Identification study preparation
   - A. Identification
     1. Gross structure
     2. Cell structure
     3. Specialized parts of cells (knobs, spines, diatom wall markings, flagella)
   - B. Use of key
     1. Simplified pictorial guide for fresh-water algae
        Algae in Water Supplies by C. Mervin Palmer
        U. S. Dept. of Health, Education and Welfare
        Division of Water Supply and Pollution Control
        Washington, D.C. (about $1.00 per copy--EXCELLENT)
     2. Specialized by
        How to Know the Fresh-Water Algae by G. W. Prescott
        Wm. C. Brown Company, Publishers
        Dubuque, Iowa (about $3.95 per copy--very good)

III. Laboratory investigations
   - A. Field trips to different areas where pollution is suspected and where pollution is not common.
   - B. Ecological study in natural environments of certain factors which act as selective agents. (water, chemical elements, gases, temp., light, current)
   - C. Ecological study in artificial environment of same factors but controlled. (effect of copper sulfate, O_2 content, effect of blooms on fish, etc.)

IV. Independent topics for further study
   - A. Significance of algae in water supplies
   - B. Taste and odor algae, filter clogging algae, polluted water algae, clean water algae
   - C. Economic importance, etc.

V. References

Laboratory - Diversity in Algal Communities

Taken from Life in the Laboratories by Donald G. Humphrey, Henry Van Dyke and David Willis, Harcourt and Brace Inc., New York, 1965 edition (Lab #25)

References: G. G. Simpson and W. S. Beck, Life, Second Edition, Chapter 19.
C. N. Palmer, Algae in Water Supplies, U. S. Public Health Service, U. S. Govt. Printing Office, Washington, 1962.

Although algae are important as food producers they also can wreak havoc with drinking supplies. As increasing numbers of people require more and more water, concern about the algae that grows in the water supplies has increased. It is interesting to note that different communities of algae are characteristic of different water conditions. In fact, certain indicator species are used to diagnose water quality.

In this laboratory study, you will become acquainted with the various kinds of algae and will become aware of the biotic factor involved in water supplies.

The publication Algae in Water Supplies will be an indispensable aid in your study. Copies of it will be available during the lab period.

PROCEDURE

Classification of Algae

Algae were at one time grouped in a single taxon, or classification unit. Modern systematic studies have revealed the diversity of the plants included under the common name of algae. They range from the simple blue-greens (Cyanophyta) through the large marine browns (Phaeophyta). Consult the classification in Algae in Water Supplies, pp. 12-14. You will find representatives of the various algal groups on demonstration in the lab. Sometime during the period you should visit the display and become familiar with representative forms.

Identification of Algae

This portion of the lab is designed to accomplish the following:

1. Provide practice in identifying different groups of algae.
2. Illustrate the variations in communities of algal plants.
3. Correlate algal indicators with different qualities of water.

Common names, such as diatoms, desmids, armoted flagellates, euglenoids, greens, blue-greens, yellow-greens, browns, golden-browns and reds identify a number of larger groups of algae. Most of the specific kinds of algae, however, have only scientific names.

Fortunately, only a fraction of the total number of algae need to be considered from the standpoint of serving as indicators of water quality. For convenience, most of the algae of importance in water supplies may be characterized in four general groups: the blue-green algae, the green algae, the diatoms, and the pigmented algae flagellates. (This list is a simplification of the grouping that would be used in more extensive treatises on the classification of algae, but the few miscellaneous forms encountered can be handled as exceptions). A comparison of the more significant characteristics of the four groups of algae in water supplies is shown on page 8 of Algae in Water Supplies.

Assemblages of different kinds of algae make up definite communities, and the quality of fresh water supplies can be diagnosed by studying these different communities. Certain species are characteristic of clean water, others live typically in polluted water. In order to identify the algal community in any water supply, careful study is required, and an identification key

is essential for distinguishing the many genera species encountered. In order to use an identification key you must know certain essential characteristics that should be observed in any specimen before the key can be used for its identification. Review the following characteristics and refer to them when necessary. (A more complete discussion can be found in Chapter III of Algae in Water Supplies.)

1. Gross Structure

Gross structural forms encountered among the algae include unicells, colonies, filaments, tubes, strands, and flat or bent membrances of cells.

2. Cell Structure

The three main parts of many algal cells are protoplast, the cell wall, and the outer matrix. The protoplast may contain pigmented bodies, known as plastids or chromatophores. Other bodies such as nuclei, crystals, starch grains, oil droplets and spherical pyrenoids may be present. The presence or absence of any of these bodies aids in identification.

The cell wall is commonly a thin, rigid structure surrounding the protoplast. It may be cellulose, as in green algae, or it may be composed principally of silica, which may be beautifully sculptured as in the diatoms.

The outer matrix, when present, tends to be a flexible, colorless, gelatinous material.

3. Specialized Parts of Cells

Specialized parts of cells are useful as identification aids. Some cells have a gelatinous stalk by which the cell attaches to other objects. Knobs or spines may be found extending from the cell wall. Swimming cells are often supplies with flagella extending from certain portions of the cell. Diatoms have a number of specialized structures. (Refer to page 14 of Algae in Water Supplies for a detailed description.)

4. Specialized Parts of Multicellular Algae

In multicellular algae the shape of the end of a filament is an important diagnostic character. The end cells may be essentially the same as other cells or they may have either a gradual or abrupt decrease in width to a point or even a long spine or hair. Some blue-green algae have filaments that are swollen or covered with a caplike membrane.

Now turn to the identification key on page 68 of Algae in Water Supplies. To use this key, first observe a living specimen in order to determine its essential characteristics. In the dichotomous key, 1a and 1b are compared with one another and with the key characteristic of the specimen at hand. When you have determined the correct alternative you will note a number at the end of the line. Turn to the place in the key where that number is listed on the left hand side of the page, and consider the alternatives a and b found there. Repeating the process, continue through the key until a name for the algae, rather than a number, is given at the end of the line. This should be the name of the specimen at hand.

When a name has been reached in the key, check the illustrations and despcriptions of the species in Algae in Water Supplies to confirm your identification. If wrong, check through the key once again with greater care. As you might guess, practice is an important factor in gaining facility with identification keys.

Obtain a sample of the algae labeled X. Use your microscope in order to study its morphology. Follow through the key until you arrive at the proper identification. Check your identification against the illustrations in Algae in Water Supplies. If at first you don't succeed, try, try again.

Now that you have some practice in the use of an identification key, you are ready to determine the quality of the water samples. At the stock table will be samples of water from four water sources. The algae in these water sources have been collected as representative samples

from actual algal fresh water communities. With a thorough bit of detective work you should be able to diagnose the quality of water in the sampled source.

Obtain a sample of the algae in one water supply. Identify at least four or five kinds. This will give you a clue to the community, and you can classify the source on this basis. Record the species or genera identified and your quality diagnosis on the table on the Report Sheet. Classify at least two water supplies, preferably more if you have time.

Turn to Chapter X, p. 50, in Algae in Water Supplies and study the additional problems caused by algae in water supplies.

Independent Studies

Now you are able to study water samples from local areas and determine the quality of the water. Follow the guide for field trips as given in your Student Information Sheet for Pollution Study. Collect a sufficient amount of water and bring to lab. You are free to work any time the lab is free. If you would like to see the effect of various ecological factors, set up your experimental design and check with me. Groups may work together and pool results.

SAMPLE REPORT SHEET FOR ALGAE STUDY

SAMPLE No.	
Representative species or genera	Kinds of algal community indicated (check one)
1.	Clean Water
2.	Polluted Water
3.	Surface Water
4.	Filter Clogging Algae
5.	Taste and Odor Algae
6.	
7.	

SUPPLEMENTARY MATERIALS FOR INFORMATION ON ALGAE

Taken in part from the teacher's manual for the Yellow Version of BSCS, Revised Edition 1968

Books

Alexopoulos, C.J. and H. C. Bold, Algae and Fungi, Macmillan, New York, 1967.
Delevoryas, T., Morphology and Evolution of Fossil Plants, Holt, Rinehart & Winston, New York, 1962.
Lewin, R.A., Physiology and Biochemistry of Algae, Academic Press, New York, 1962.
Prescott, G.W., The Algae: A Review, Houghton Mifflin Company, Boston, 1968.
Sinnot, E.W. and K.S. Wilson, Botany, 6th Edition, McGraw-Hill, New York, 1963.
Smith, G.M., The Fresh-Water Algae of the United States, McGraw-Hill, New York, 1950.
Tilden, J.E., The Algae and Their Life Relations: Fundamentals of Phycology, Hefner, New York, 1937.
Weisz, P., and M.S. Fuller, The Science of Botany, McGraw-Hill, New York, 1962.

Articles

Bonner, J.T., "Volvox, A Colony of Cells," Scientific American, Vol. 182 (5) (1950), p. 52.
Echlin, P., "The Blue-Green Algae," Scientific American, Vol. 214 (4) (1966), p. 74.
Milner, H.W., "Algae as Food," Scientific American, Vol. 189 (4) (1953), p. 31.
Moore, E.G., "Artificial Living Plants," Scientific American, Vol. 195 (4) (1956), p. 118.
Weiss, F.J., "The Useful Algae," Scientific American, Vol. 187 (6) (1952), p. 15.

Films

"Simple Plant--The Algae" (sd, b&w or c, 18 min) p or r, EBE
"Microbiology, Part II: Microorganisms with Chlorophyll," No. 8 (sd, c, 32 min) p or r AIBS (McGraw-Hill)
"The Diversity of Plants, Part VII, The Algae, No. 2" (sd, c, 28 min), p or r, AIBS (McGraw-Hill)

Film Loops

"Algae Syngamy-Isogamy in Chlamydomonas" (c, 3 min, 45 sec), Ealing
"Algae Syngamy-Oogamy in Oedogonium" (c, 3 min, 55 sec), Ealing
"Algae Syngamy-Zygote Formation in Pandorina" (c, 3 min, 50 sec), Ealing
"Chlamydomonas Reinhardti-Reproduction and Life Cycle" (c, 5 min) Ealing
"Liberation of Zoospores in the Algae-Oedogonium" (c, 3 min, 10 sec) Ealing

Identification Keys

Prescott, G.W., How to Know the Fresh-Water Algae, Wm. C. Brown Company, Dubuque, Iowa, 1964.
Palmer, C. Mervin, Algae in Water Supplies, U. S. Department of Health, Education and Welfare, Washington, D.C.
Edmondson, W.T., Fresh-Water Biology, Wiley, New York, 1959.
Needham, J.G., A Guide to the Study of Fresh-Water Biology, Comstock Publishing Associates, Ithaca, New York, 1957.

Algal Culturing

"Growing Fresh-Water Algae in the Laboratory." Turtox Service Leaflet No. 6. (free)
Send to Turtox Service Dept. CCM: General Biological, Inc., 8200 South Hoyne Ave., Chicago, Illinois 60620.

Ward's Culture Leaflets: No. 5, "Culture Media for Protozoa and Algae" (free)
No. 14, "Culture of Algae in the Laboratory" (free)
Send to Ward's Natural Science Establishment, Inc., P.O. Box 1749, Monterey, California, 93940.

Equipment

Sylvania Gro-Lus Fluorescent Culture Lamp provides the proper radio or red to blue radiation for enhancing the growth of algae.
Concentrated Media for Culture of Algae and Ciliates is sold by Turtox under the name "Turtox Universal Concentrated Algae Medium (61V170) and is especially formulated to grow Volvox, Spirogira, Zygnema, etc.
All purpose Algae Medium (LM86e) is sold by Carolina Biological Supply Company, Powell Laboratories Division, Gladstone, Oregon 97027.

ALTERNATE OR OPTIONAL LAB ACTIVITIES

"Millipore Experiments in Microbiology"
Millipore Corporation
Bedford, Massachusetts 01730

Experiment 7--Detecting pollution in water by coliform bacteria counts.

These bacteria are always found in the intestinal tract of man and animals and are excreted by the billions in the feces and find their way to the water supply with sewage. They are not harmful themselves, but their presence is a sure indicator of sewage pollution, and the almost certain presence of other bacteria (e.g., Salmonella typhosa) that <u>are</u> harmful.

Students will be easily able to see the colonies which have a shiny, greenish surface, and can count the total number of these "green sheen" colonies appearing on the filter.

Using the Millipore "Sterifel Filtration Apparatus" is a good way, and it can be purchased for $12. Millipore filters (white gridded HAWG 047 SO) box of 100 filters and 100 pads costs $16.50. The filters can be permanent records and unlike conventional agar cultures, colonies grown on Millipore filters can be preserved.

Population Pollution

In connection with population, students could perform a growth study of microbial populations (e.g. coliform types from the above experiment) and possibly apply to a human population growth pattern.

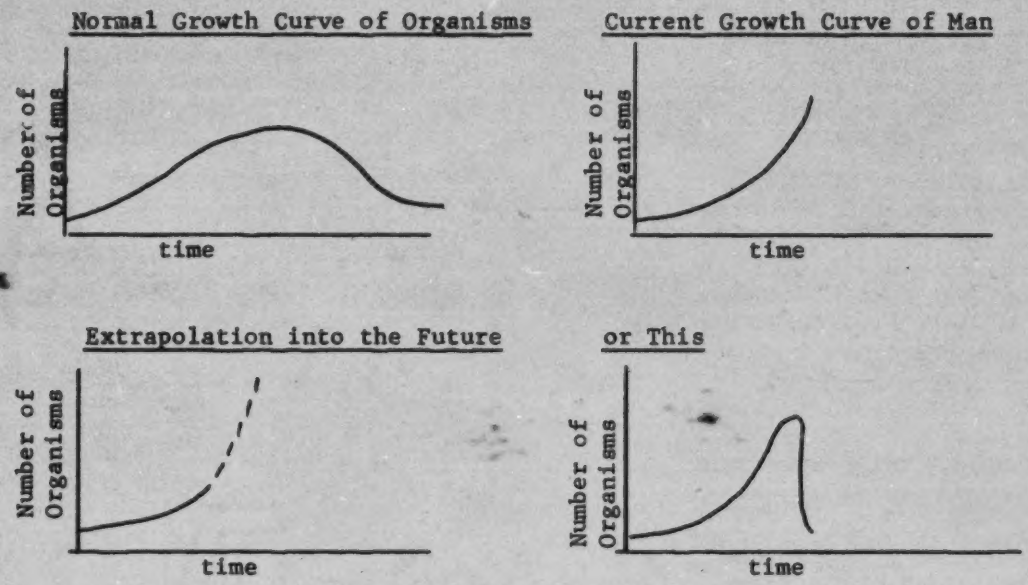
Growth can be measured in various ways (weight increase, size) but a relatively straightforward method which can be applied to microbes is simply counting the number of individuals. Students could plot a growth curve through the various growth phase pattern, A) Lag phase, B) Logarithmic phase, C) Maximum Stationary phase, D) Death phase.

Reference for the technique for counting cells is well done in
"Microbes: Their Growth, Nutrition, and Interaction"
BSCS Lab Block by Alfred S. Sussman pp. 35-53.

Extrapolation of Human Growth Curve

Rather than growing bacteria on agar, a simple yet impressive lab can be performed using a simple broth mixture.

With a sterile swab, the student could take a sample of bacteria by rubbing the swab behind his ear and inoculate a broth mixture contained in a screw-top test tube (a closed system). If the study was to continue for seven days or so, seven test tubes could be inoculated at the same time. The increasing cloudiness of the solution would be a visible indication of population growth. Each day's samples could be taken from one of the tubes, and examined. This would allow successive studies without introducing outside variables. Ultimately, the growth will kill itself because it is existing in a closed system and toxins and wastes will mount. Students could then speculate on human population within the closed system of the test tube earth.



The following are good sources for free or low-cost informational materials on population, conservation and ecology:

Zero Population Growth 367 State Street Los Altos, California 94022	Newsletter, brochures, ecology leaflets, reprints,
Population Reference Bureau 1955 Massachusetts Ave. N.W. Washington, D.C. 20036	Good bibliography, source list, and film guide on population. Minimal cost.
Planned Parenthood, World Population 515 Madison Avenue New York, New York 10022	Bibliography, film guide and following reprints: "Eco-Catastrophe" by Paul Ehrlick, "300 Million Americans Would be Wrong" D. Lilienthal, "The Human Race Has Maybe 35 Years Left" D. Lyle.

National Wildlife Federation 1412-16th Street N. W. Washington, D.C. 20036	Conservation Directory--a guide to all state and natural sources of conservation and environment information. $1.50. Informational packets on ecology and pollution--special packets from elementary to adult level. Excellent Monthly Newsletter.
American Association of University Women 2401 Virginia Avenue, N.W. Washington, D.C. 20037	Resource Directory on Pollution Control. 75¢ Anti-pollution pamphlets and study guide. 75¢ (excellent materials)
National Parks Association 1701-18th Street, N.W. Washington, D.C. 20036	Free or low cost pamphlets and articles on thermal pollution, noise pollution, pesticides, and basic ecology. Excellent.
Conservation Foundation 1250 Connecticut Ave., N.W. Washington, D.C. 20036	Variety of pamphlets and articles dealing with many aspects of ecology.
Sierra Club Mills Tower San Francisco, California 94104	Lists of publications, pollution, population information, protection of scenic areas.
Project Man's Environment National Education Assn. 1201-16th Street, N.W. Washington, D.C. 20036	Information on curriculum (K through 12) environmental study areas.
Isaac Walton League of America 1326 Waukegan Road Glenview, Illinois 60025	"Clean Water--It's Up to You"--excellent pamphlet on what local citizens can do about water pollution. Free. Monthly Conservation Letter.
Environment Magazine 438 N. Skinker St. Louis, Missouri 63180	Monthly publication dealing with the effects of technology on the environment. Published by Committee for Environmental Information.
Public Affairs Pamphlets 381 Park Avenue South New York, New York 10016	Pamphlet #421 "An Environment Fit For People" - 25¢ #403 "The Battle for Clean Air" 25¢
Portland Center for Continuing Education P.O. Box 1491 Portland, Oregon 97207 Attn: Mr. Lawless	"Observing Our Environment" - $3. Relating elementary students to the environment.

THE S-A-S APPROACH APPLIED TO THE STUDY OF POLLUTION ON THE SECONDARY LEVEL

The S-A-S approach could easily be incorporated into an in-depth study of the environment pursuing in particular the various aspects of pollution. Presently, I feel that many students are acutely aware and gravely concerned with the spiraling problems of pollution. Daily newspapers provide ever-increasing evidence that America is wantonly ravaging her landscapes, waterways and atmosphere at a rate unparelleled in other countries. It would seem that our highly technological society might inevitably be the cause of our own self-inflicted destruction if limits are not enforced and a workable solution proposed.

Assuming that awareness and concern are already a part of the student's thinking, the task of the teacher is to be a motivating force, stimulating student reactions into action-oriented studies. During the past school year, our biology class attempted to do something constructive to help build a better world. As a teacher, it was my first objective to motivate interest in ecology and the environment by using openings during class discussions to start the students questioning to what degree the state of today's environment will affect the state of their environment in the immediate and long-range future, and how effectively can they now control this future. Secondly, I hoped to help them learn to think objectively and critically by making judgments based on research and/or experiments, rather than upon hearsay. They were asked to question the credibility of conflicting reports and seek reliable sources (based on subjective evaluation) for confirmation. Lastly, my job would be achieved when they recognized the immediate problems and began to seek solutions. I attempted to let students take the initiative and act as an encourager rather than a dictator. This at times took quite a bit of restraint but at the end of the study, I felt that this was indeed a most rewarding experience for me and the class.

Working on the premise that hearsay is not valid evidence for either the pro or con stand on the problem, students began gathering reading materials. Slower students handled newspaper accounts easily; the readers tackled current paperbacks and articles and gradually all began to realize that an uninformed public could be disastrous. They sought to become knowledgeable and to make others more aware. Since the study of pollution is comprehensive, students were encouraged to become "classroom authorities" on specific aspects of particular interest. For example, I will list some of the approaches:

1. Students living near a large electrical power plant in Salem began to study the effects of thermal pollution on marine life and the pollutants resulting from fossil fuel.
2. A study of a controversial city incinerator brought to the students' attention the problem of handling a city's solid wastes.
3. Peabody students studied the effects of the industrial wastes from the city's leather tanneries deposited into the North River.
4. Some worked on the problem of soapy water being dumped by local car washes.

Students became disturbed when they began to recognize so many local problems. They concluded that legislation was necessary to force companies to clean up. Since the students could not vote, they decided to show the adult public the discoveries. Realizing that a picture is worth a thousand words, small independent groups armed themselves with instamatic cameras loaded with slide film and began collecting visual data. As the films were developed, class seminars were held and student photographers showed this visual data and the class as a group analyzed the ecological implications. This audio-visual

approach was perhaps the most effective segment of the project. First, rather than the teacher pointing out polluted sites, the students sought examples and verified with research why the given area posed an environmental threat. The fact that the school had students from at least 10 surrounding towns and cities gave the study a fairly comprehensive view of the North Shore area. The cities ranged from large populations to small populations; from inland to coastal; from industrial to rural; from a wealthy type of community to a ghetto and the class got examples of each of the phases of pollution in the various communities. Every community supplied ample evidence that pollution was indeed a visible problem.

If a pollution project is to follow this S-A-S approach, laboratory work should be another important phase of the study. I would suggest as possible investigations the following ideas, stressing water pollution:

1. Algae in water supplies could be studied as indicators of water contamination.
2. Coliform counts give an indication of sewage pollution and are easily recognizable.
3. Filtration studies detect the presence of oil in water.
4. Commercial detergents kits can be used for studying the phosphate concentration.
5. Fluorescin dyes can be used as tracers in domestic septic tanks for determining the amount of sewage contamination.

Many books and guides now available give the teacher many workable approaches suited to local circumstances. Students should be encouraged to follow through on related experiments and urged to design their own experimental procedure. Spontaneous independent study can provide the more capable or interested students with an excellent opportunity to experience both public and private science. It would be my opinion that student interest should gear the type of lab work undertaken, and sometime accidental inquires should be followed if possible. For example, in our study we had a bloom of algae suddenly begin growing in one of our aquaria. The class decided to wait and see what effect the growth would have upon the fish. They were amazed at the rate the bloom reproduced itself. This accidental lab experience led to several "offspring" problems and a study of algae growth conditions, O_2 content, and pH of the water were tested for a period of time. Several of the students collected H_2O samples from two local rivers and brought them to Boston for chemical analysis. Here the men of the Department of Water Pollution Control explained the techniques involved.

As the students became more involved, many new avenues were opened and many extracurricular hours were spent going to various agencies. Some agencies were extremely helpful; others less so. Students experienced both reception and rejection, a very good learning process.

In all, our study extended over a period of eight months, and was integrated into the BSCS Blue Version course. However, most of the project work was done after school, although whenever members had experiences to relate, class time was always available. The class wrote and shared their research and, much to my amazement, interest spiraled with each new find. By early April, stimulated by the coming Earth Day, it was decided that a program should be drawn up and presented to the public. However, we were a bit late. Preparation time was too limited, and the group wanted to do a really efficient job. Groups of similar interest began pooling findings and ideas and compiled a summary using the best from each one's paper. Several groups correlated their slides with the paper to give a visual impact. Again as a teacher, I wondered how such a synthesis would work. I kept hopeful that by now they had become critical

thinkers and would present a balanced view. They did and they had made the decisions. When they read their report, I think it pleased them when they saw how pleased I was with their hard work. Then each group selected a spokesman to represent them. Practice "speech" sessions were held and the spokesman taped his presentation and the group members gave powerful suggestions for improvements. This criticism, support and encouragement by peers welded an esprit de corps. I encouraged them to be as scholarly as possible since they were attempting to reach an adult audience. In passing, I should say that this was a type of class one meets probably once in a teaching experience.

In the final phase, they did present a thoroughly documented program. It was presented to the entire school, the adults and to other schools. The program began with a film which emphasized air pollution and all types of mechanical pollution. Various phases were discussed by student spokesmen. Other members formed a panel and held a questioning period. The program concluded with Paul Erhlich's tape on "Eco-Catastrophe" which was reinforced by graphic slides of the North Shore area. The students felt that they had reached their goal. They were involved actively and were helping to make others more aware of the environmental problems existing in local areas. They had worked hard and felt a sense of accomplishment as a class. This summer some are working with various groups in an effort to continue building a better world. It was an enriching experience both for the students and for myself.

THE S-A-S APPROACH TO TEACHING SECOND LEVEL

"The S-A-S Approach to Teaching Second Level" by Michael F. Fleming of Council Rock Senior High, Newton, Pa. is an excellent article demonstrating the rationale for a student-dominated approach which could be incorporated into an in-depth study for an environmental/ecology education program. Rather than paraphrasing the article, I think it would be more beneficial to hold for the most part, to the actual ideas Mr. Fleming has presented in his format. The article appeared in the March, 1970 edition of The American Biology Teacher, pp. 168-169.

The first topic to be discussed was "What is S-A-S?"
S-A-S stands for "science-as-science." It is concerned with training in the techniques of science and an attempt to experience the nature and spirit of science, the nature of science being experimental technique and the spirit being inquiry. When one teaches a science course using an S-A-S approach he is attempting to afford the student a realistic experience in the nature and spirit of science. He is trying to eliminate an approach based on lecture and rote memorization of facts--an approach devoid of thought and understanding. Mr. Fleming believes that a course in science should be steeped in reflective thinking and student participation. He says that we must approach student participation from the standpoint of the student as a unique person working as an individual scientist solving problems, while at the same time interacting with his peers. We must afford the student an experience in science that is designed to prepare him not only for future academics but, equally important, for his role as a responsible citizen.

The second point discussed "Science: Private and Public."
In an S-A-S approach the student experiences private science. Private science includes the lab activities of the scientist. When at all possible the student works individually, experiencing the scientific approach to problem solving. He gains experience in formulating hypotheses, designing experimental approaches, carrying out research, and collecting and analyzing data. He then presents his findings to the rest of the class. It is at this point that the student

experiences public science and the lay public. The student should experience the role of the scientist in presenting data orally, as in a lecture, or in a written form, as in a scientific paper. In other words, the student should experience both roles of a responsible citizen living in an age of science. Actually, the seminar becomes a microcourse, if you will, in a form of rhetoric--a microcourse dealing with all those mechanisms necessary for clear, concise communication between human beings. The student must be afforded an opportunity to develop the ability to speak and write clearly, tersely and factually. This, Mr. Fleming believes, is seriously lacking in many present day science courses. The seminar is a clearing house for all that goes on in the laboratory. In addition to paper presentations, the seminar can deal with laboratory techniques, procedural problems and the drawing of conclusions, among many other topics.

Another important phase of an S-A-S approach is spontaneous independent study. The class begins as a unit working on a project; but the student interests vary, and any problem will usually arouse a whole list of "offspring" problems. This provides an excellent opportunity for a student to begin independent study of the problem. The initiative should come from the student, not the teacher.

What is the role of the teacher in S-A-S?
If at all possible, the teacher should be gagged or muzzled and kept out of the way of student activity. He can make or break the course. He makes it by being a catalyst, by setting the stage and getting things into action. The inability of the teacher to allow students to work independently, to make mistakes, and to find their own solutions results in total failure of an S-A-S approach.

In concluding the article, Mr. Fleming states that this introduction to S-A-S is presented for comment, criticism and consideration. It is not presented as a panacea, but as a different or modified tool for inducing a realization of what science is all about.

INTERDISCIPLINARY APPROACH FOR AN ENVIRONMENTAL STUDY

All educators must accept a major role in helping the new generations develop the necessary knowledge and skills to prevent the rapid growth rate of environmental degradation and to undertake restoration of the environment to levels that allow maximum development of human potentials.

An interdisciplinary approach would be an excellent way to have both students and faculty become actively involved. Any such program would take good planning to be effective, and it would be most natural that some teachers might feel unqualified to undertake such a project. Here the biology department could provide assistance and encouragement by making materials available before the actual program began and holding "teach-in" sessions with individuals or groups. Because of the non-scientific background of many, the faculty could decide the duration of the "teach-in," a day or two or possibly one day a month. Faculty enthusiasm and student interest would be determining factors.

Charles E. Roth, Director of Education for the Massachusetts Audubon Society, Lincoln, Massachusetts proposed the following suggestions for the various subject areas:

Physics-	Nuclear power, its benefits and hazards
Chemistry-	The chemistry of air pollution
Biology-	Population dynamics
General Science-	Ecological principles
Earth Science-	The effects of mining on environments
Problems of Democracy	Property rights and responsibilities of the population
American History-	Development of the frontier ethic in America and the effect on modern America
World History-	The history of land abuse through the ages, especially around the Mediterranean
Anthropology-	How other cultures view the man-land relationship
Geography-	Population vs. resource distribution
Home Economics-	The consumer in a throw-away culture
Industrial Arts-	Where do our wastes go?
Physical Education-	Recreation and open spaces
Language Arts-	Pollution and other resource problems in the country of their language
English-	The man-land relationship in literature--Aldo Leopold's The Sand County Almanac, Steinbeck and others.
Mathematics-	The role of statistics in population projections, etc.
Art-	The role of design in building a positive new environment
Guidance-	Environmental careers
Music-	Noise pollution
Psychology-	Environmental stress and crowding

ENVIRONMENTAL TOPICS FOR PHYSICAL SCIENCE 13

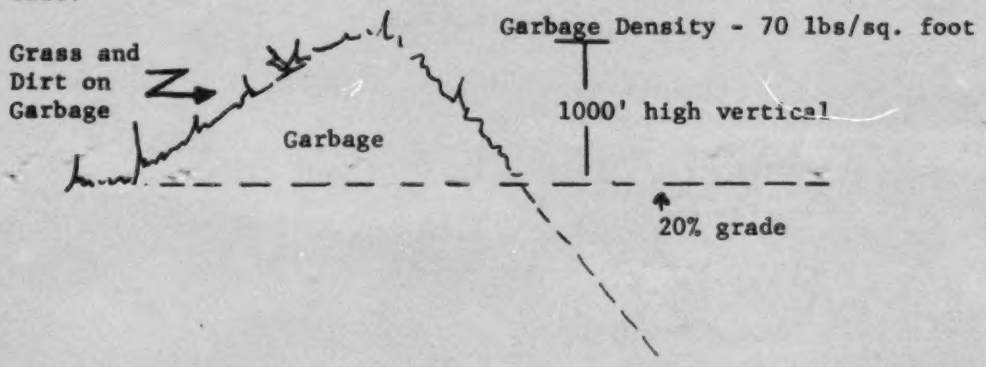
Edward R. Wagner

Introduction

Topics for study and projects might include garbage pollution, loss of grazing land, transportation problems, effects of internal combustion, air pollution and light intensity, air pollution and reflectivity of planets, radioactivity as a pollutant, thermal pollution and nuclear reactors, air pollution and the greenhouse effect, smoke stack pollution, sound pollution, erosion and smoke pollution. Here are some suggested problems:

GARBAGE POLLUTION

A New York businessman has found a use for this garbage which has been packed into high-density blocks. There is a great interest in skiing in the New York area and a noticeable shortage of skiable mountains, so it is feasible to build a garbage mountain for skiing with snow-making facilities and a ski-lift.



Problems:

How much garbage is needed? Volume? Weight?

N.Y.C. produces 4.12 lbs. of garbage per person daily. How long will it take to accumulate enough garbage to build the ski area?

Where is the garbage dumped now or if it is not used to build the mountain?

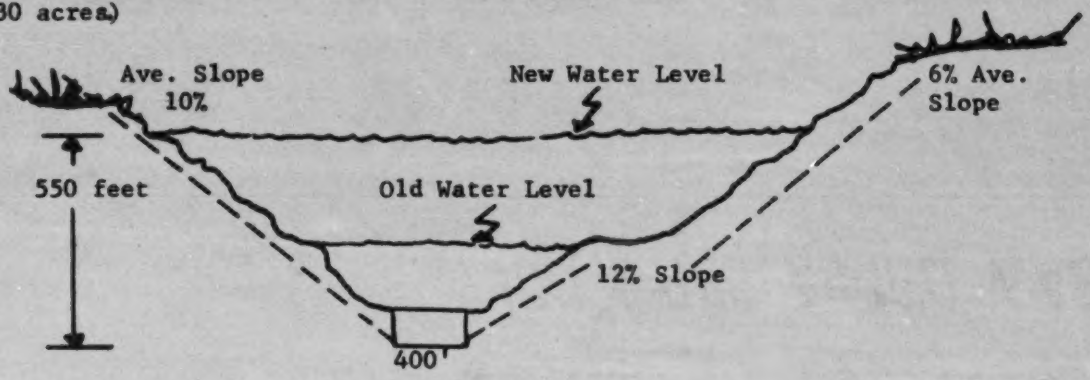
Why is this bad?

LOSS OF GRAZING LAND

Problem:

The Columbia River in Washington State has many dams blocking its flow. These dams increase the speed of the rivers, so man-made lakes are formed.

However, these lakes flood important winter pasture land for wildlife. This in turn decreases the size of the deer herd. The question arises, how many deer died during the winter? (Assume a certain acreage is needed to a deer --say 30 acres)



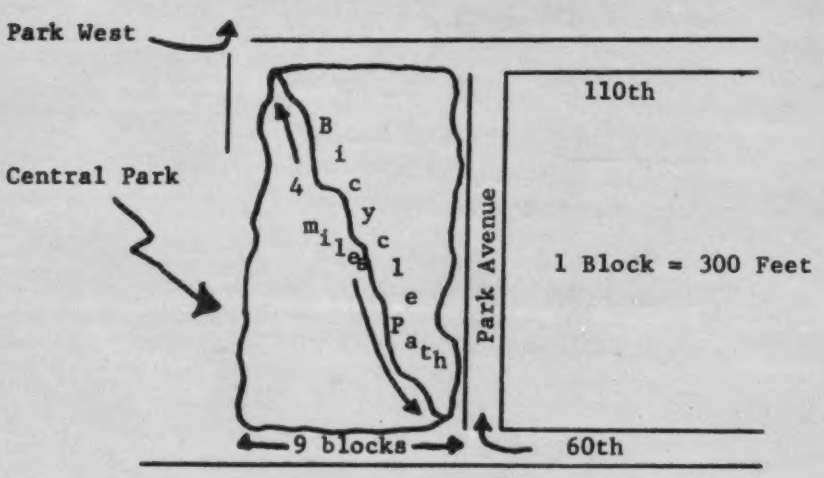
. The river was widened to the above dimensions for a total length of 100 miles. What was the effect on the deer population?

TRANSPORTATION CRISIS

Time - Speed - Distance

Concentration of gases - Estimations

Bicycle vs. Car



Starting here, 60th and Park, go north to Park West. Which way is fastest? By bicycle or car? Why?

If it is "stop and go" on four-lane Park Avenue, how many cars exist between 60th and 110th Street? (Estimate)

In "stop and go" traffic a car consumes .015 gallons of gasoline for each block traveled. Estimate the total quantity (in pounds) of undesirable gases produced by

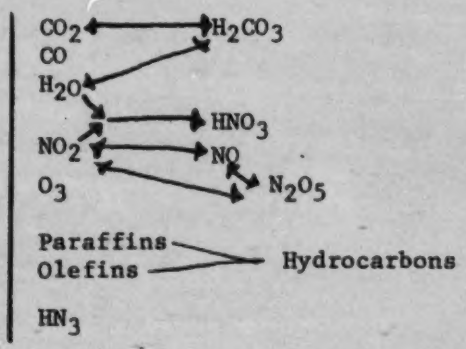
1. each car in going the distance of the park
2. the entire day's traffic

What is the quality of the air in Central Park?

Facts to Remember

1. .015 gallons of gasoline will require 11.0 ounces of air for proper union within the engine.

2. 34% of the exhaust fumes by weight will consist of the following gases:



The average American uses 21,000 gallons of gasoline per lifetime. How many pounds of noxious gases are produced from gasoline in the U.S. each year?

EFFECTS OF INTERNAL COMBUSTION

Heat and Gases

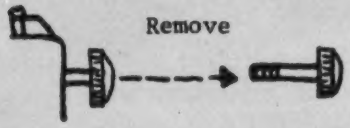
Experiment: The gasoline engine
Input ⟶ Output

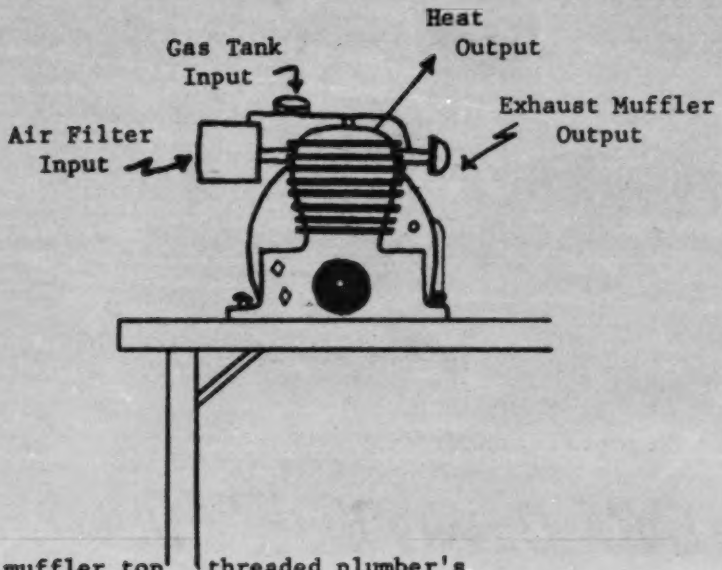
Qualitatively and quantitatively estimate the input materials and output products of a small one-cylinder four-cycle gasoline engine.

Apparatus: lawn mower type engine, several gallons of leaded regular gas, graphic equipment for curve plotting, stop watch, and chemical analysis equipment.

DANGER CONDUCT EXPERIMENT IN "OPEN-AIR" AREA NEAR LAB!

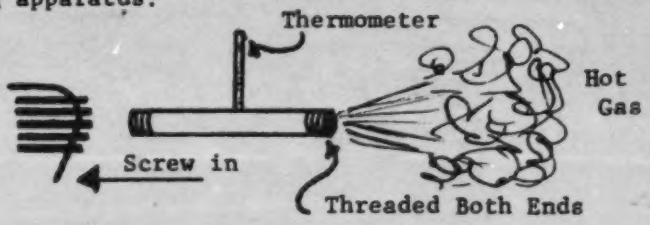
Note: Unscrew muffler exhaust



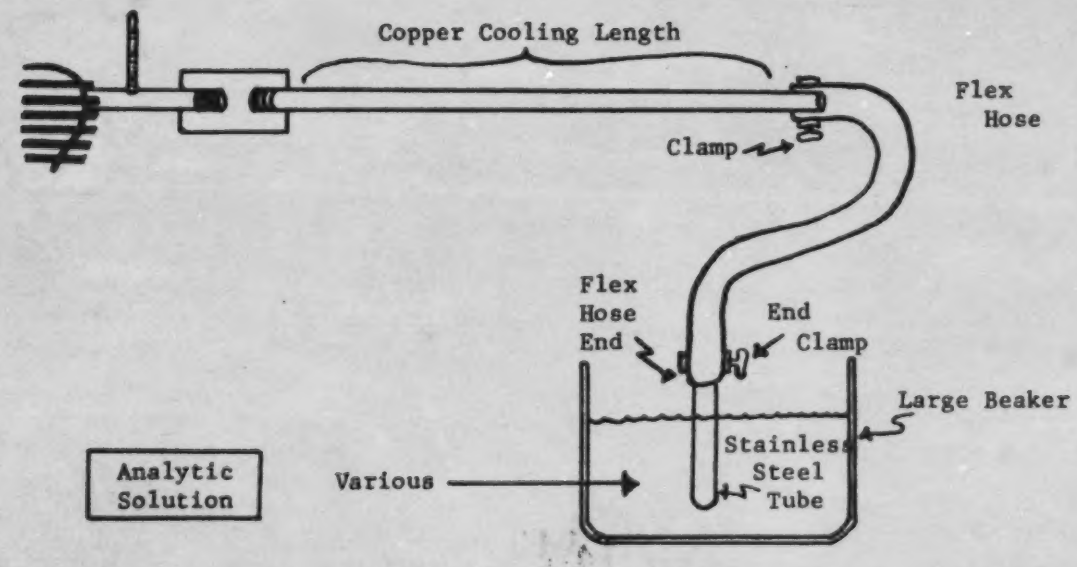


ADD to threaded muffler top threaded plumber's tubing and the following apparatus:

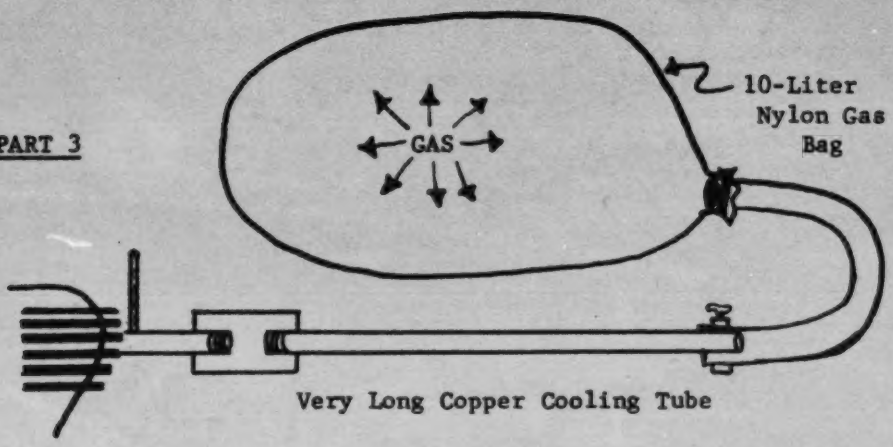
PART 1



PART 2

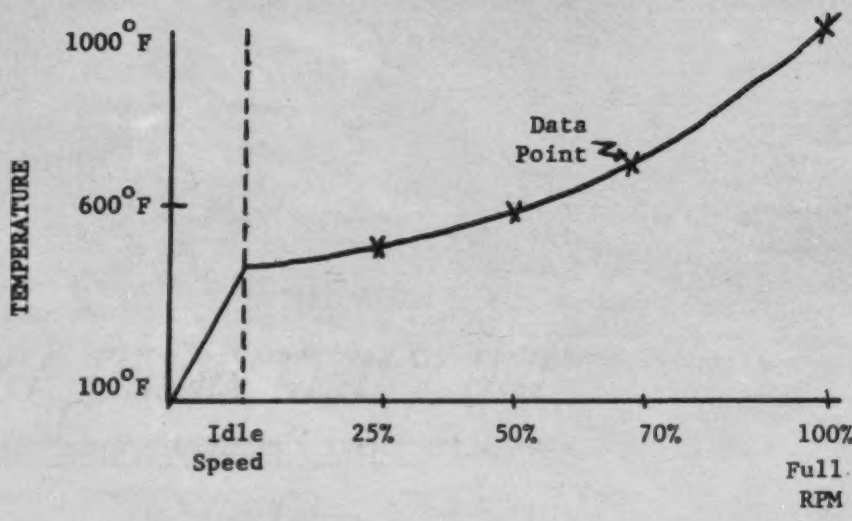


PART 3



Procedure:

Part 1: Note temperature changes of gases after engine is started. At various throttle speeds temperatures are recorded.

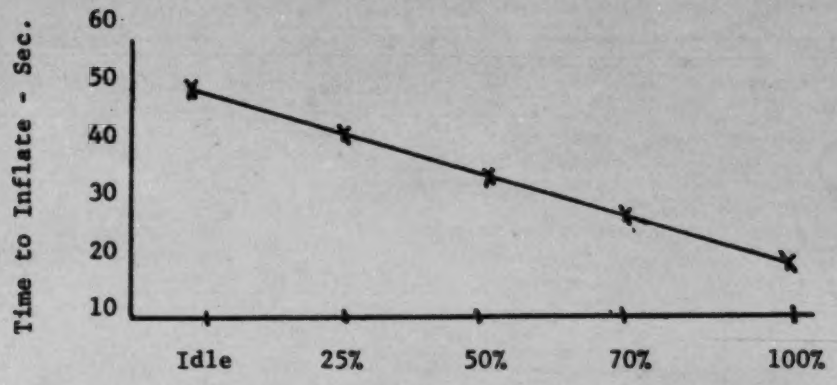


Part 3 should be done in conjunction with Part 1.

Part 3: Gas Bag Collection

Observe the inflation of bag with time. Use stopwatch.

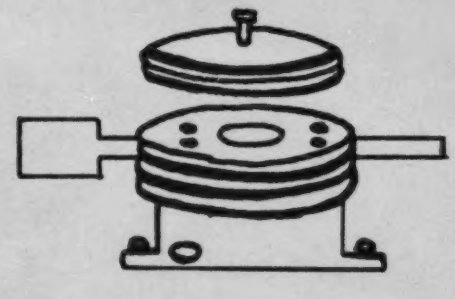
Fill in the following data curve:

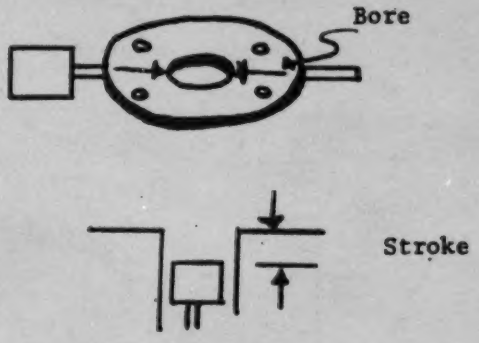


Knowing the amount of gas produced per time and the temperatue, what is the amount of heat added to the local environment? What is the effect on the quality of the air we breathe?

Scaling Up to Car Engines

Take off engine head





Calculate engine displacement. Now reassess quantitatively the results for the following engines:

Car	Displacement (Cu. In.)
Chevrolet	350,427
Ford	302,390
Plymouth	383,440
Cadillac	500 Cu. In.

It has been estimated the Russian SST aircraft consumes 800 lbs. of air per second.

Part 2 - Qualitative Analysis

In the large beaker, the following tests can be performed:

Test for	Method
acid	litmus
base	litmus
H_2O	condensation
CO_2	lime water (MILKY)

CO (carbon monoxide)

H_2CO_3 (carbonic acid) + $BaCL_2 \longrightarrow BaCO_3$

NO_2 (nitrogen dioxide) (per)

HNO_3 (nitric acid) + H_2SO_4 + $FeSO_4 \longrightarrow$ Brown Ring

N_2O_5 (nitrogen tetroxide)

NH_3 (DH) (ammonia) + $HCL \Rightarrow NH_3CL$ (Particulate - White)

NO (nitrogen oxide)

Olefins)
Paraffins) (hydrocarbon fumes) hydrocarbon odor

Lead

$Pb + H_2SO_4 \longrightarrow Pb\ SO_4$ (White)

$Pb + K_2C_rO_4 \longrightarrow Pb\ C_rO_4$ (Yellow)

$Pb + KI \longrightarrow Pb\ I_2$ (Yellow)

Conclusions:

Knowing how much air is used and temperatures, calculate the heat generated per second, at idle and full power. Remember, heat is also given off by metal parts of the engine. Where does this heat go? Does the hot exhaust heat the atmosphere?

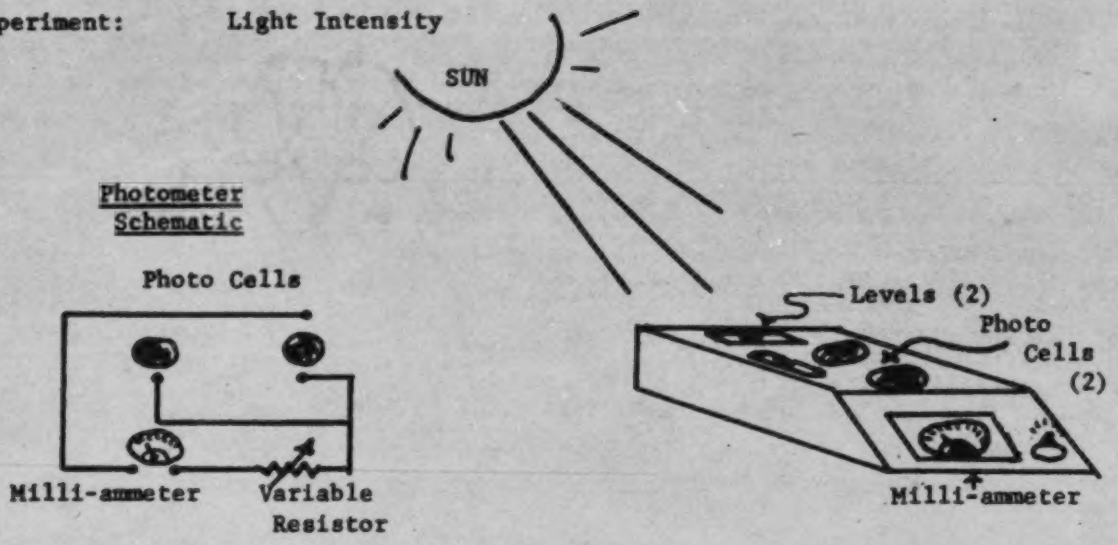
Are undesirable gases generated by the engine? In what quantity are they produced by the Cadillac? Do car emissions affect the quality of the environment where you live?

List all compounds and elements found in engine exhaust gas. Are any poisonous?

Estimate the amount of air you breathe in a minute and then compare that to what the Russian SST uses in a minute.

AIR POLLUTION AND LIGHT INTENSITY

Experiment: Light Intensity

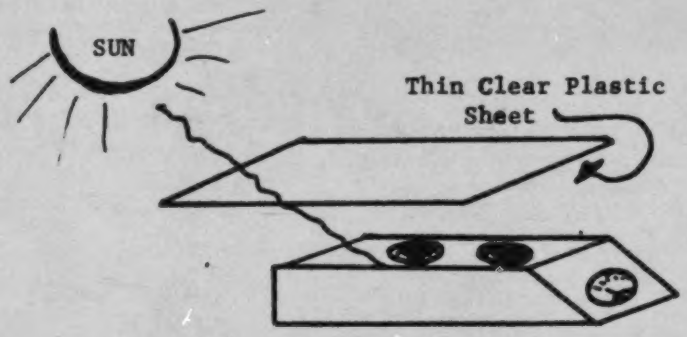


Object: Study light intensity (solar radiation under various conditions)

Apparatus: The above illustrated device may be constructed in classroom or at home. If the proper size cells and ammeter are selected the variable resistor may not be necessary. Use a thin clear plastic sheet.

Procedure and Purpose:

PART 1



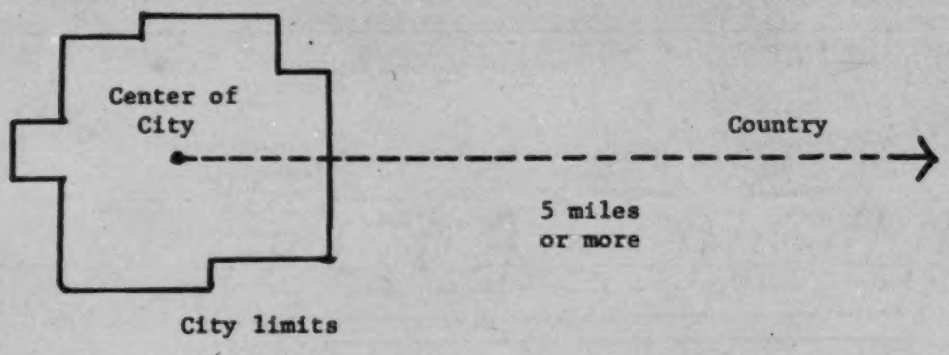
Readings are taken using photometer when sunlight passes through clear plastic sheet. Rust is added to the sheet and the ammeter is observed. The same procedure is followed with a water-mist and a water-mist and dust combination. Qualitatively what is the effect? Why does the radiant energy decrease?

This procedure may be followed with soot, smoke, etc., but remember to clean the plastic and record the control (clean) reading.

Part 2

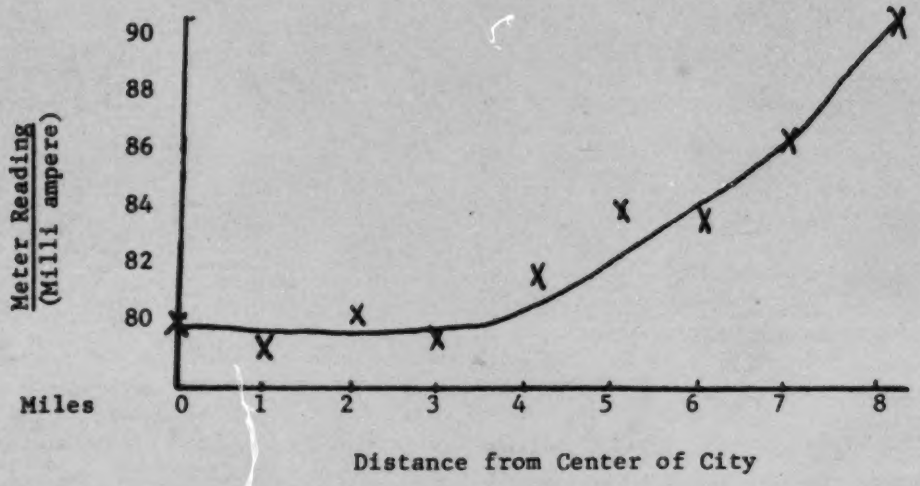
Field Project:

Take recording materials and photometer to the heart of a large city. Write down readings at five-block intervals and every half-mile out of town for five miles. Save all data. This must be performed between 11:30 AM to 12:30 PM.



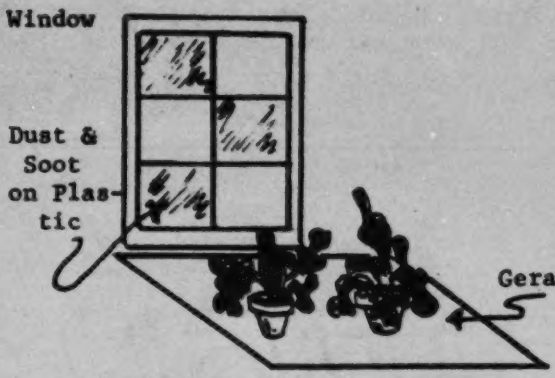
Plot the following curve:

on a "clear" day only! (between 11:30 AM and 12:30 PM)



Part 3

Qualitative Effect on Photosynthesis (Plant Growth)



Place two identical geranium plants before classroom window. Between the window and plants, place two pieces of plastic - one clear and one sooted.

Soil must be identical and watering must be uniform. Does their growth seem different?

Conclusions:

Do mist, fog, smog, dust, soot and haze affect the amount of radiant energy reaching the earth? Why?

When clouds block the sun what does the meter read?

On a "clear" day in the city are the above substances in the air?

What is the percentage of increase of light five miles from the city?

Does the quality of the air vary much within city limits?

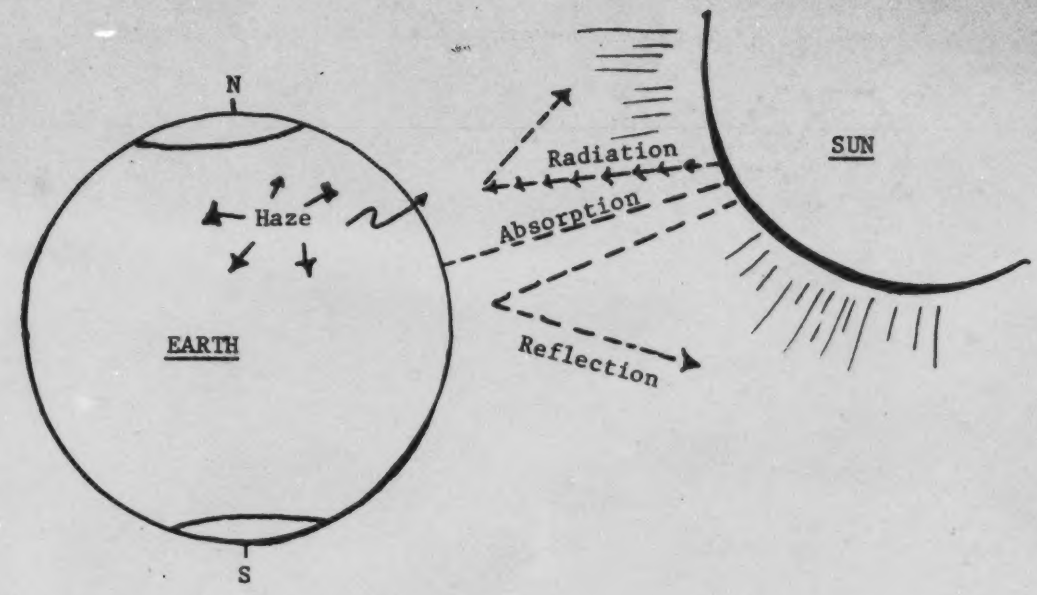
Does air pollution affect plant growth? Can you speculate how animals may be changed by this environment? How about people?

AIR POLLUTION AND REFLECTIVITY OF PLANETS

Absorption
Reflectivity
Cooling

Problem:

The sun constantly shines on the earth. Part of the sunlight is absorbed by the earth, part is reflected by the atmosphere. Due to man's polluting the atmosphere a haze has been building up around the earth. This haze is most intense in the sky near cities where there are a lot of people. Even though most "sky pollution" is most evident in urban areas, it affects all the earth. The amount of solar energy has decreased at the earth's surface.



The loss of energy due to increased reflectivity has a cooling effect generally on the earth.

Q. What is the "haze" made up of?

Q. Where does this matter come from?

The earth's average absorption coefficient - $C_{A\ Earth}$ is given below with year:

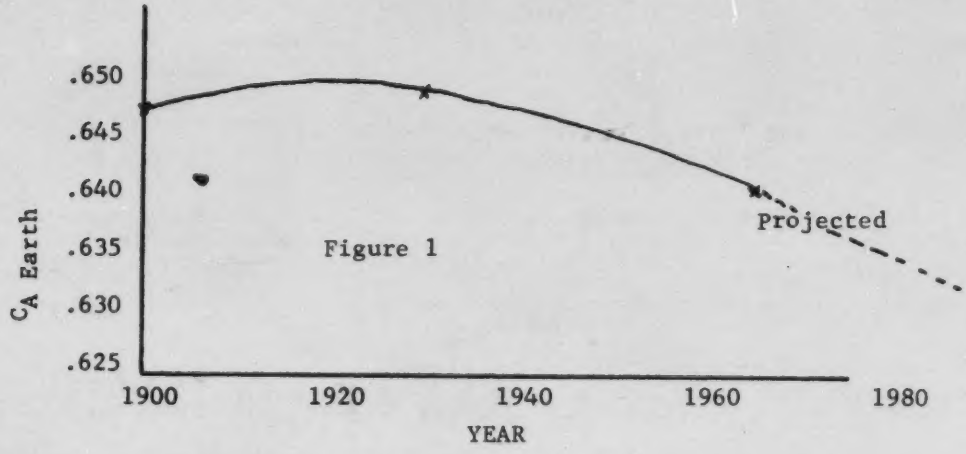


Figure 1

Change in earth's average temperature ΔT earth with change in C_A earth

ΔC_A earth

PER YEAR

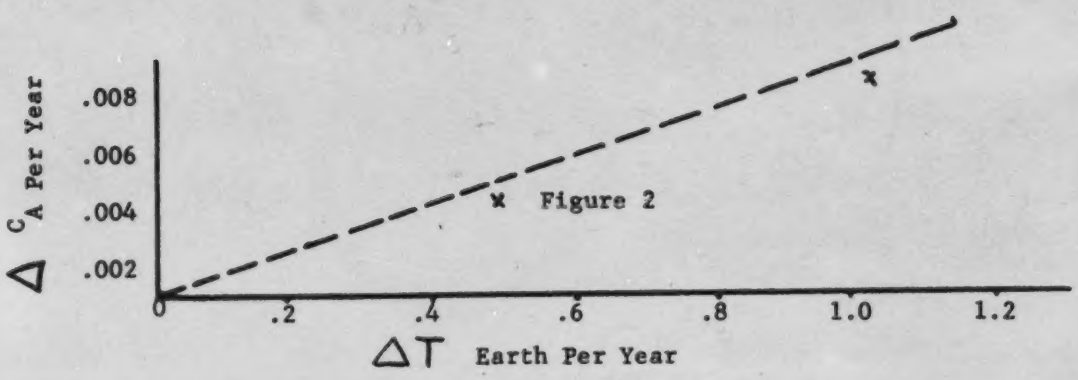


Figure 2

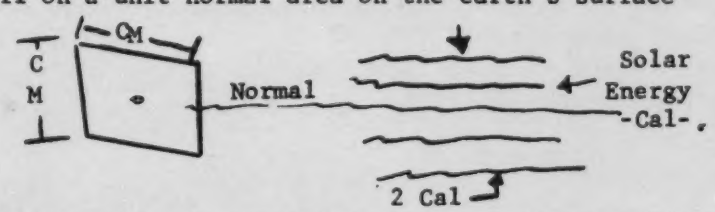
DATA

Before the year 1900 it has been estimated: 33% of all light and radiance reaching the earth was reflected.

Jet planes cause a "cascading effect" in producing cerous clouds which are very reflective. They seed the upper atmosphere with condensation many miles long forming huge, high altitude "problem clouds."

Jet planes alone have seriously modified the 33% normal reflectivity.

Presently $\approx$ ½ CAL/sq CM' fall on a unit normal area on the earth's surface



Utilizing figures 1 and 2 determine the average temperature change of the earth for the next year. For 1979-1980. For 2000-2001.

What will be the total temperature change from 1970 to 1980? From 1970-2000 AD?

What effects will this have on various areas, cities, etc. of the earth?

What will happen to the area of the ice caps? Shore lines and beaches?

Will you be able to swim in the ocean off Miami?

How might this trend be reversed?

RADIOACTIVITY AS A POLLUTANT

Research Project in Library

Teacher should present principles of radioactivity, half-life concept, etc. The Christmas Island thermonuclear test occurred in 1946; the island was leveled after the natives were relocated. Several years after the test flora and fauna began to appear again; however, much was changed. Nature was thrown out of balance, many mutations were noted and several species could not survive in the radioactive environment. The object of this project is to obtain information on radioactive isotopes. It should be determined what elements (and compounds) exist at the surface of the island and in what concentrations. Half-lives for these elements must be found for the radioactive state, so it can be determined which are causing radiation to linger. Estimates could be made as to future radiation levels, so it can be determined when man can return to the island. The Handbook for Chemistry and Physics is an excellent source. This is a perfect opportunity for the young scientist to learn to use the handbook and obtain an understanding of radioactive pollution.

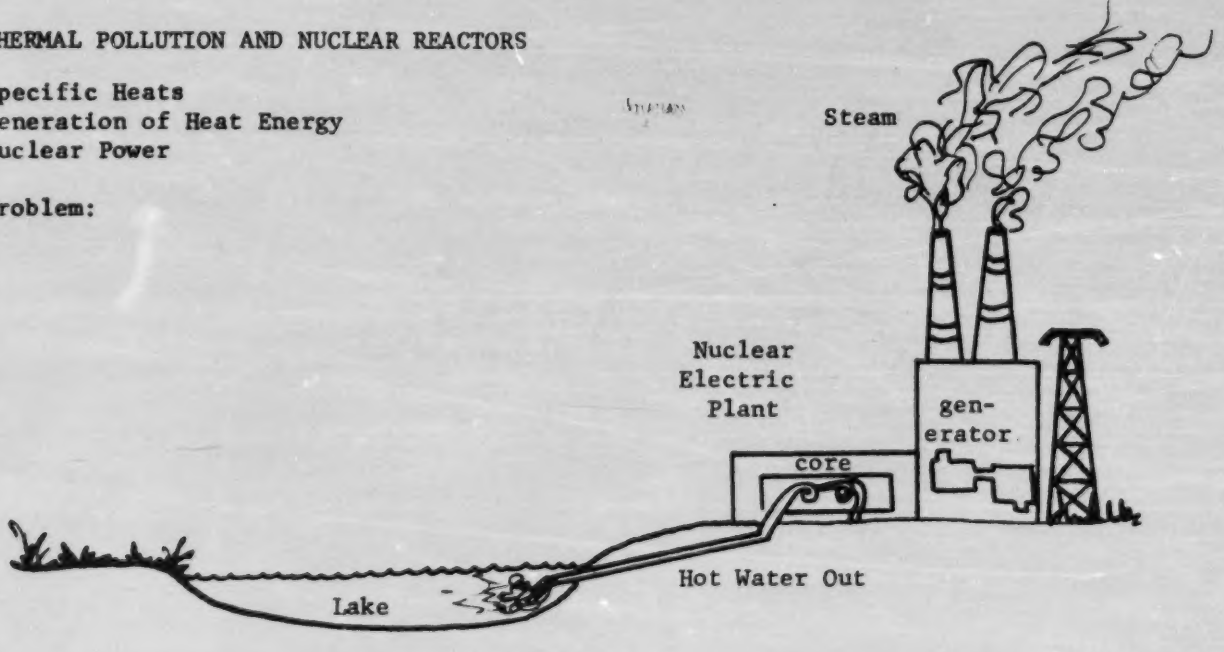
Why do the citizens of towns often reject proposals to build nuclear power plants nearby?

Element	Abundance	Half-Life

THERMAL POLLUTION AND NUCLEAR REACTORS

Specific Heats
Generation of Heat Energy
Nuclear Power

Problem:



An atomic reactor power plant (e.g., nuclear electric) needs large quantities of water for cooling purposes. Assume the plant utilizes a natural lake which is nearly round, diameter three miles, depth nine feet, and generates 10^5 BTUs per minute of thermal heat. Half the added heat is lost to the atmosphere from the heated lake. Specific heat for water is Sp = 1.0

What is the water temperature after one week of operation?

Would the lake get hotter and hotter until boiling?

AIR POLLUTION AND THE GREENHOUSE EFFECT

Absorption
Radiation
Frequency

Class Discussion:

The greenhouse effect has been used to explain the worldwide heating that has occurred during the last 50 years. It has been discussed earlier that the earth has been cooling off due to increased reflectivity of the atmosphere. This is true, but the cooling has been less than expected because there is an increase in CO_2 in the air as the reflectivity has increased.

Production of haze, fog, smog, dust and soot in the atmosphere go hand in hand with production of the gaseous pollutant CO_2. All these pollutants are the result of the activity of "modern" man. How does the higher carbon dioxide level affect the earth's temperature?

WARMING TREND

1900 - 1950	+ 1°F	10% CO_2 INC
1950 - 2000	+ 2½°F	

COOLING TREND

1950 - 2000	15°F

The following chart is from U.S. News and World Report, August 19, 1968, 65

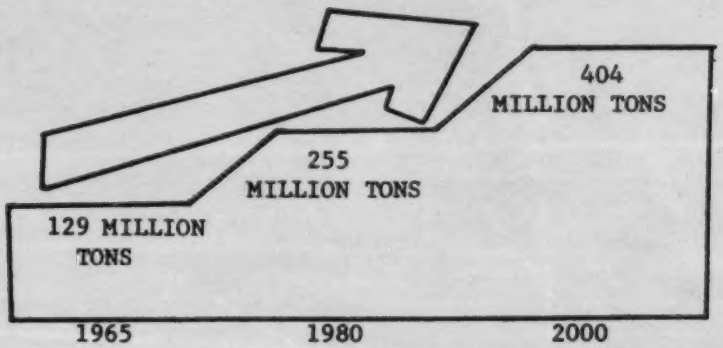
Official estimates of dirt and fumes that in future years will pollute the U.S. atmosphere unless new controls are applied.

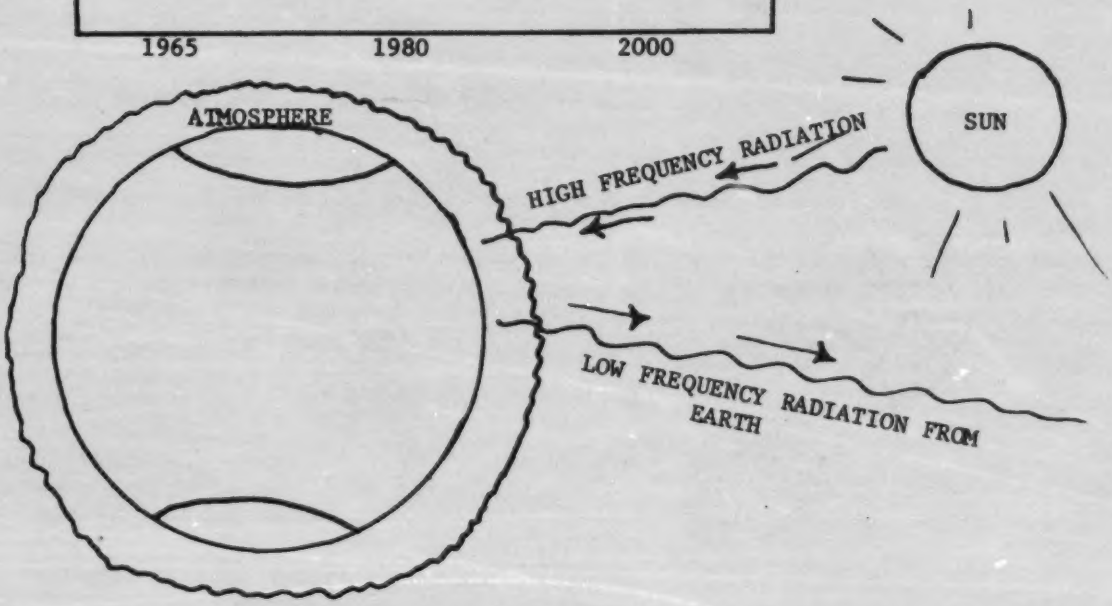
In 1965	Yearly Pollution By 1980	Yearly Pollution By 2000
25 Million Tons of Sulphur Dioxide	44 Million Tons	76 Million Tons
66 Million Tons of Carbon Monoxide	106 Million Tons	207 Million Tons

In 1965	Yearly Pollution By 1980	Yearly Pollution By 2000
16 Million Tons of Hydrocarbons	27 Million Tons	53 Million Tons
10 Million Tons of Nitrogen Oxides	17 Million Tons	30 Million Tons
12 Million Tons of Particulates*	21 Million Tons	38 Million Tons

*Dust, coal smoke and soot

How annual total of air pollutants will rise, if control measures fail --





HIGH FREQ. RAD. = HIGH ENERGY RAD.
LOW FREQ. RAD. = LOW ENERGY RAD.
This is true since $E = h\nu$

ν = Frequency Number
h = Plank's Constant

also,

Wave length λ is proportional as $\frac{1}{\nu}$

or

$$\lambda = \frac{c}{2\pi} \frac{1}{\nu}$$

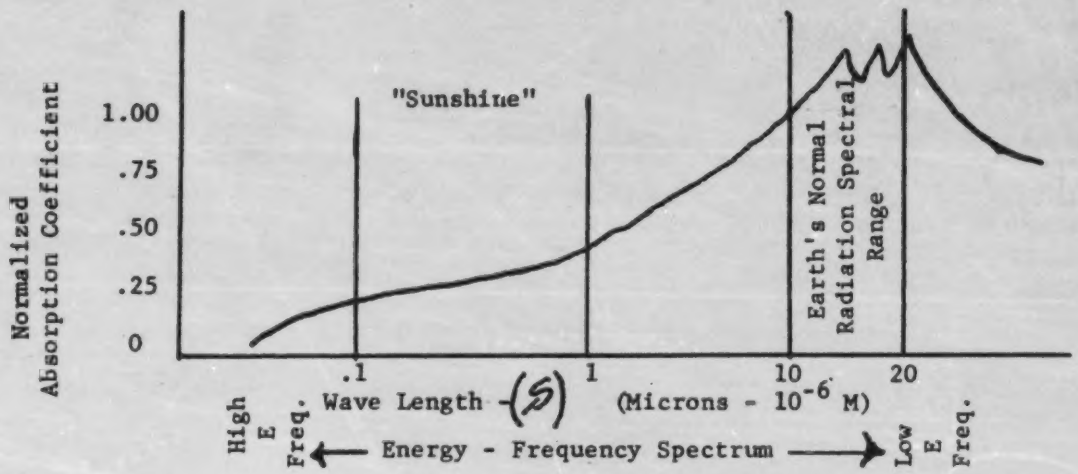
C = speed of light

So,

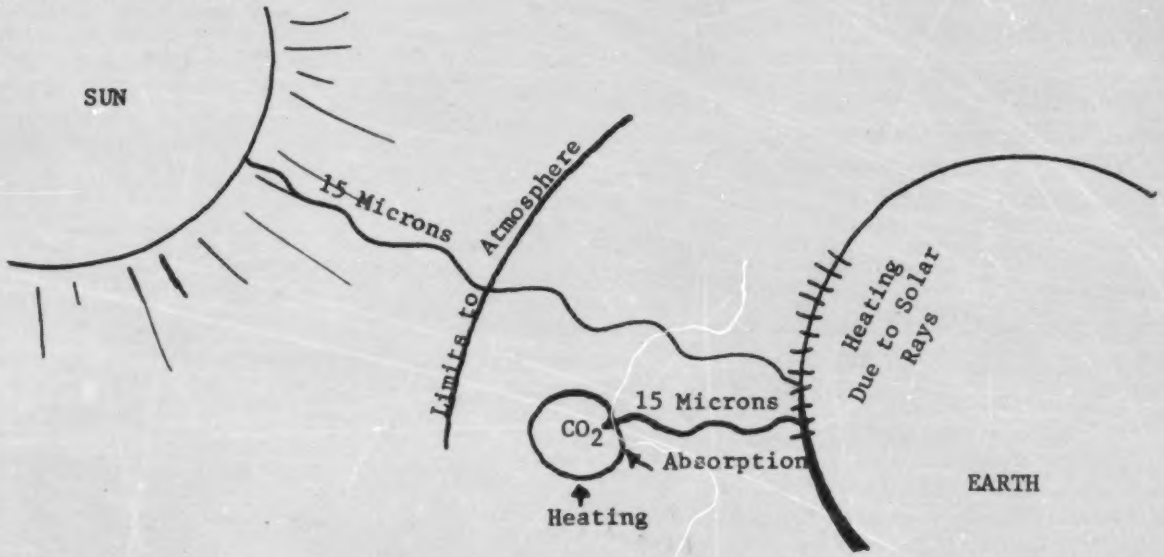
High freq. means low wave length

Low freq. means high wave length

Absorption of Electromagnetic Radiation by CO_2 rich atmosphere



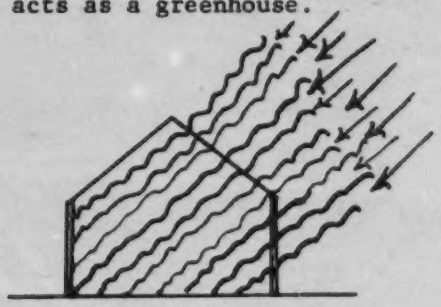
Notice high absorption of radiation in the frequency of earth's normal spectral range. This indicates that CO_2 tends to absorb large quantities of the energy that would be normally radiated into space from earth. When this occurs the radiant (rays) energy is converted into heat energy and in turn the atmosphere is warmed.



As shown above the short wave length solar energy passes easily through the CO_2 polluted atmosphere, but when the long wave length ray (energy electromagnetic) hits a carbon dioxide molecule it is absorbed and converted. The long wave length radiation comes from earth and is of low energy because the source, the earth, is a low energy source. The intensity of the energy of the rays is a function of the temperature of the source.

	The earth	The sun
Surface temperature	$\approx$ 70°F	$\approx$ 12,000°F
Mean wave length	$\approx$ .5 microns	$\approx$ 15 microns

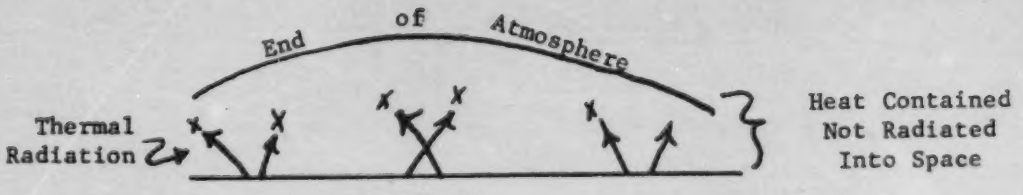
So the carbon dioxide acts as a greenhouse.



Solar Heating

Long Wave Radiation
Heat Contained

CO_2 Contaminated
Environment



Questions:

What would happen if there was no reflection cooling and the CO_2 continued to climb?

List ten sources of CO_2.

How can the production of this gas be reduced easily?

Data Reference

"Environmental Science and Technology," "CO_2" November, 1969

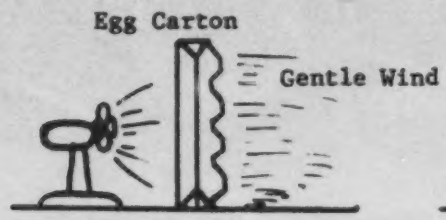
SMOKE STACK POLLUTION

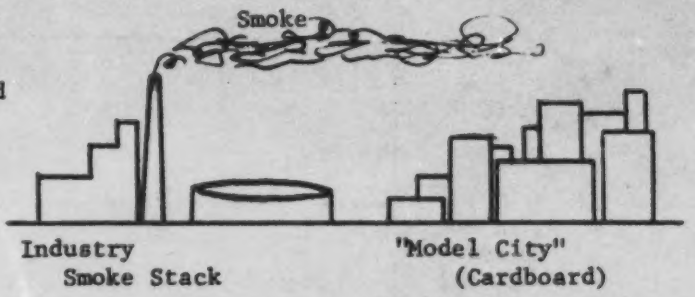
Fluid Flow
Dispersion
Gaseous Mixing

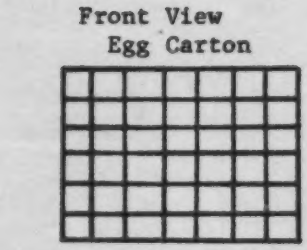
Classroom Demonstration:

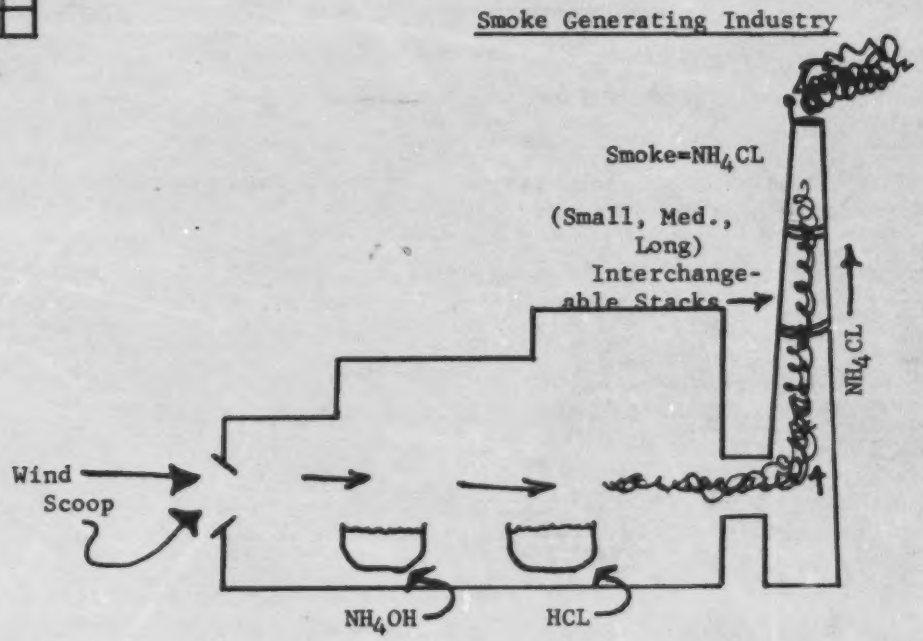
Air pollution due to smoke dispersal from a smoke stack can be studied as a classroom teacher-student demonstration. "The fundamentals of meteorology are particularly useful in predicting the degree of air pollution that will result

from specific sources." [1] The apparatus on the following will create a great deal of interest in the problem. Many variables can be controlled so a whole matrix of conditions may be generated. The experiments are performed for qualitative observations and results. Comment, interaction and discussion of the pollution problem and the nature of the physics of gas in flow are the objectives.









[1] Faith, W.L., Air Pollution Control, New York, John Wiley and Son, Inc.

Matrix of Conditions
(Smoke Rate Fixed)

Smokestack Height	HIGH	MEDIUM	SLOW
HIGH	1	2	3
MED.	4	5	6
SHORT	7	8	9

Vary distance of fan-wind tunnel to industry to obtain slow, medium or fast wind speeds.

A qualitative evaluation of various parometers under the matrix of conditions 1 through 9.

Coning

1 Weak lapse condition

2 Both vertical and lateral diffusion

3 High wind

Fanning

1 Inversion condition (temp)

2 No vertical, only lateral diffusion

3 Little vertical mixing

Looping

1 Strong lapse condition

2 Rapid mixing

3 Possible direct ground contamination

4 Unstable atmosphere

Above are the three major smoke plume types that will be observed. 1. The maximum ground level concentration of pollution is inversely proportional to square of effective smoke stack height. 2. Downwind pollution is inversely proportional to wind velocity. 3. Topology affects mixing.

Questions:

Under what conditions does the very polluted plume reach the ground? Does it touch down on the city?

Can any effect be seen upon the buildings? How about the people?

If there is no wind, the fan is off. Where does the smoke go?

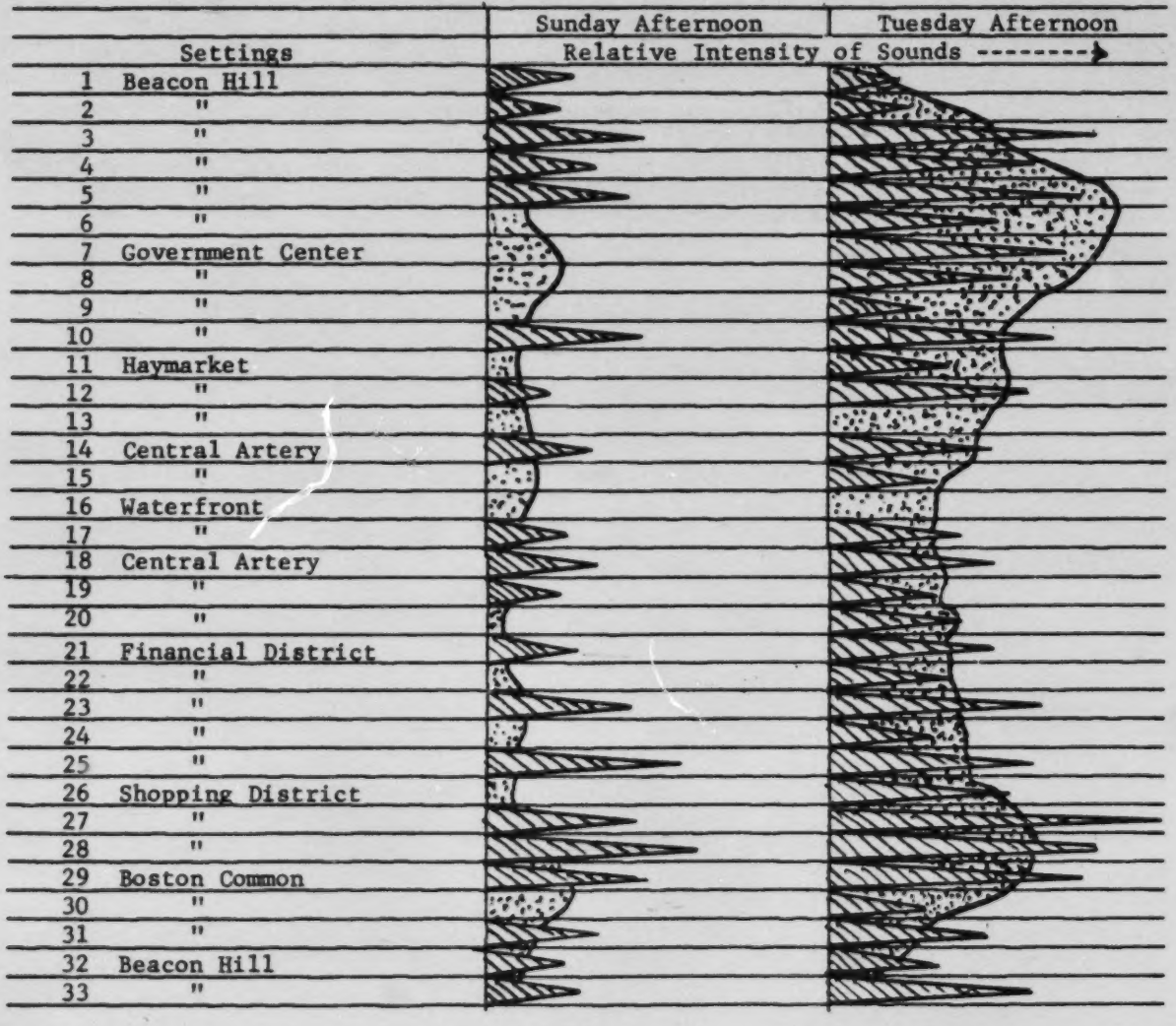
How can the pollution problem be remedied?

SOUND POLLUTION

Sound
Intensity
Energy

Problem:

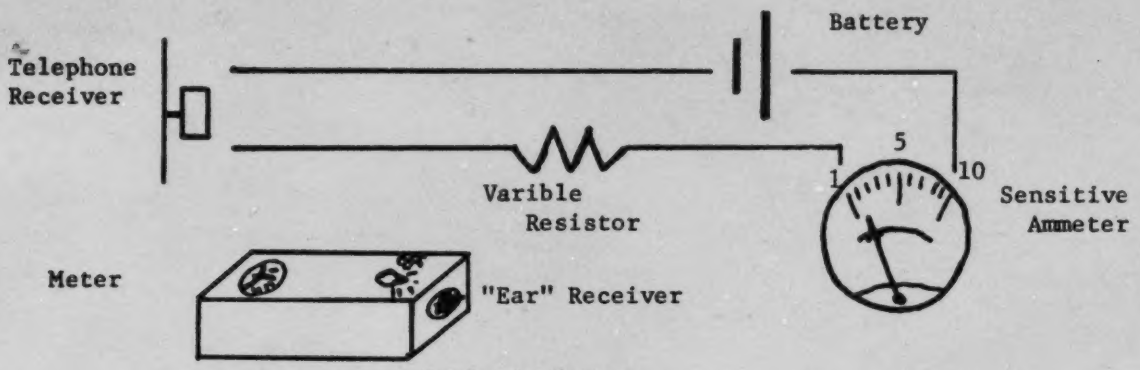
Measure and study sound intensity out-of-doors at a variety of locations, times of day and days of week. It will be necessary to construct a simple apparatus. This study of sound pollution may be easily related to study of sound, radiation, intensity and energy of longitudining waves.



Data from Boston, Massachusetts is presented to show how a similar project was performed; however, it was not an environment education activity.

Apparatus

SCHEMATIC



Mechanical Ear

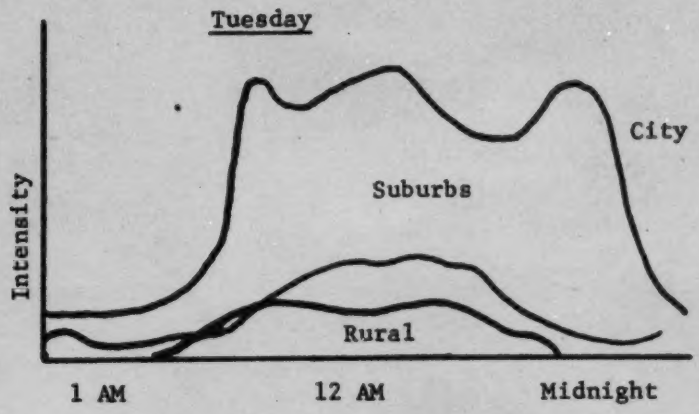
These "mechanical ears" could be made in shop classes.

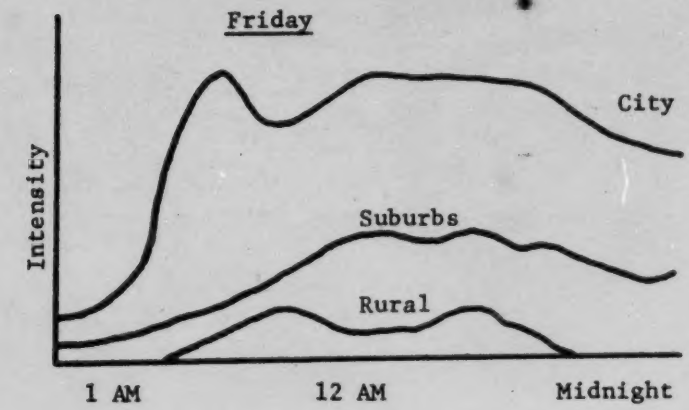
The reading on the ammeter (1-10) will correspond to the relative (normalized) sound intensity, e.g., pollution level. The sensitive variable resistor setting must be set per the components of the system. All data must be recorded, saved and plotted. The following matrix of data conditions must be observed:

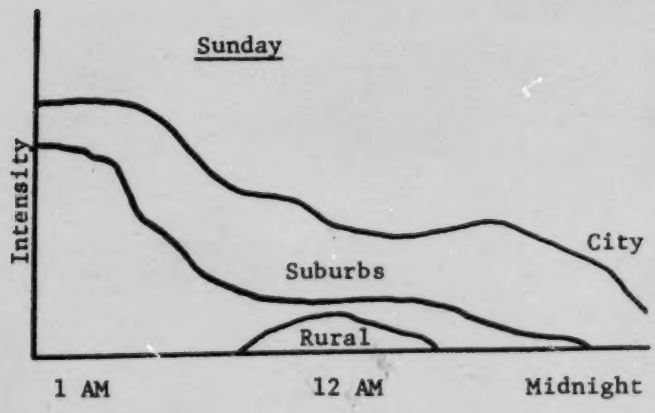
DAY	TIME	CITY	SUBURBS	RURAL
Tues.	7:30 AM			
	2:00 PM			
	10:00 PM			
	5:00 AM			
Fri.	7:30 AM			
	2:00 PM			
	10:00 PM			
	5:00 AM			
Sun.	7:30 AM			
	2:00 PM			
	10:00 PM			
	5:00 AM			

The above data must be recorded.

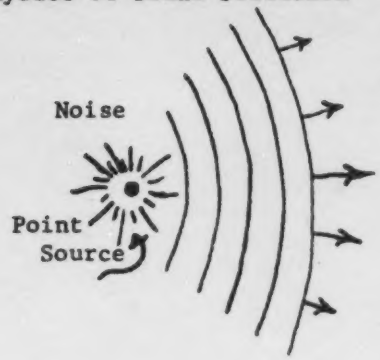
PLOTS:


Tuesday
Intensity
City
Suburbs
Rural
1 AM
12 AM
Midnight


Friday
Intensity
City
Suburbs
Rural
1 AM
12 AM
Midnight

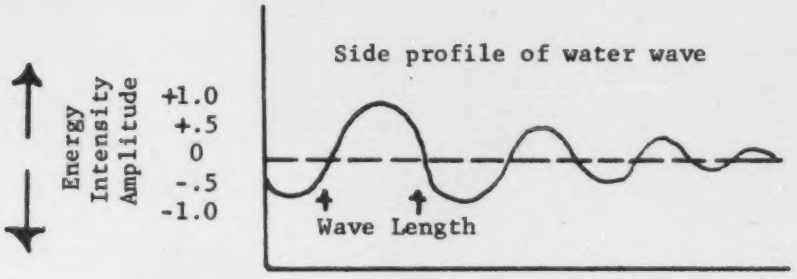

Sunday
Intensity
City
Suburbs
Rural
1 AM
12 AM
Midnight

Physics of Sound Pollution



LONGITUDINAL WAVE FRONTS AS IN WATER WAVES

U = Speed of Sound $\approx$ 760 m.p.h.



$$\text{ENERGY} \approx \text{INTENSITY} \approx \text{AMPLITUDE} \approx \frac{1}{(\text{Dist})^2}$$

TOTAL EFFECTIVE NOISE IS:

$$\text{NOISE INTENSITY} = \sum \left(\text{Point sources as } \frac{1}{(\text{dist})} \right)$$

Questions:

Why is the sound pollution concentration highest in the city environment?

Is it better on the tenth floor of a tall building? Why?

Why is there less a problem on Sunday? At 2:00 PM? 5:00 AM?

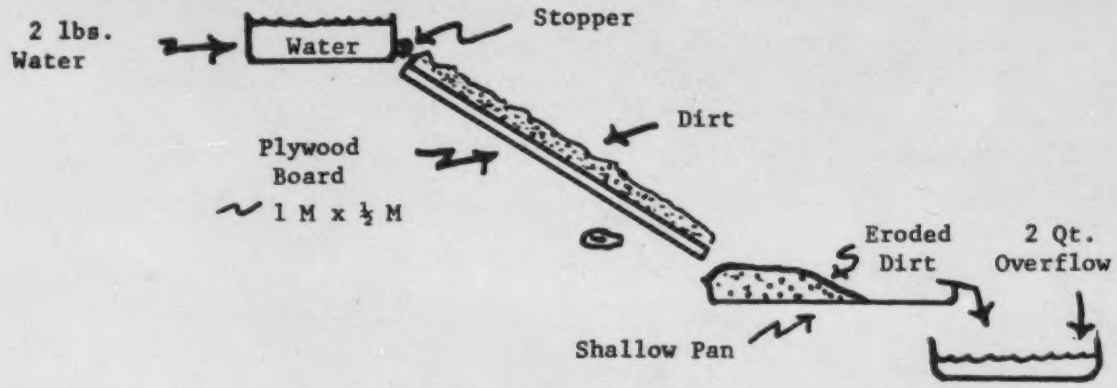
What can be done to correct the situation?

EROSION

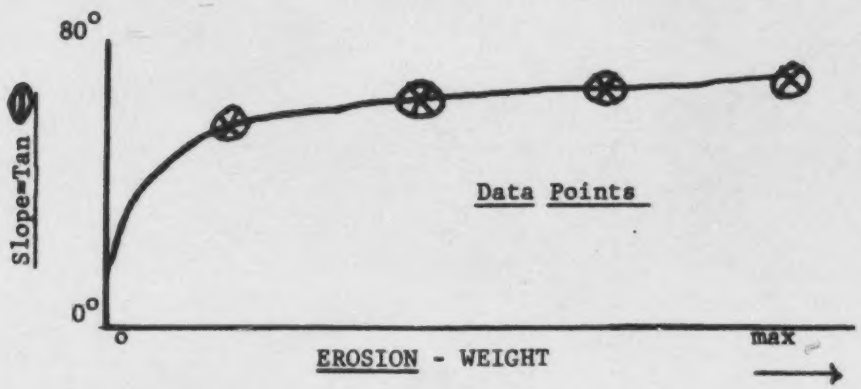
Potential - Kinetic Inergy
Clear-cutting

Group Projects:

Clear-cutting trees on a hillside gives rise to erosion problems. With some very simple, inexpensive homemade equipment this can be studied in class.

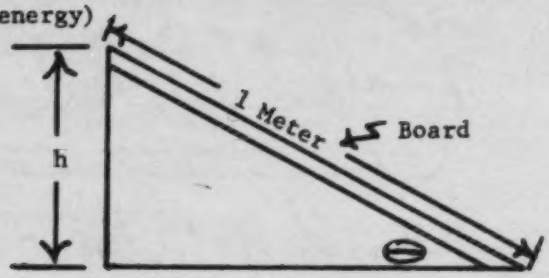


Procedure:
1. **Fill upper basin with one quart of water**
2. **Make sure dirt is level and then remove stopper!**
3. **Watch erosion of dirt; after water stops weigh washed dirt down to collection pan.**
4. **Repeat process several times using different slopes.**
   Remember:
   Slope = Tan ⊖ Measure ⊖ with protractor
5. **Plot data:**



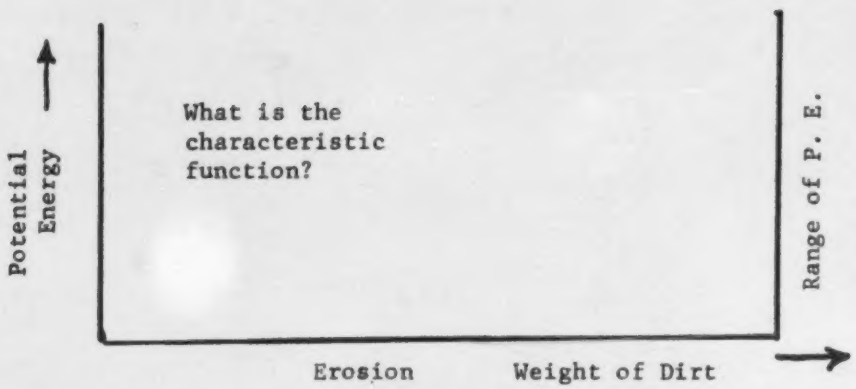
What is the function describing this?

Physics of Erosion (energy)



1. one quart weighs ≈ 2 lbs.
2. height: $h = 1\ m \times \sin\theta$
3. Potential energy = weight x height (w x h)

   $P.E. = 2\ lbs \times 1\ m \times \sin\theta$
4. Kinetic energy expended is approximately equivalent to the P. E.
5. Calculate P. E. for all slope combinations plot:



Questions:

Why does erosion increase as slope and potential energy increase?

Is this effect linear - what happens to erosion as slope is doubled? Why?

What does clear-cutting do to erosion?

How can hillside erosion be prevented?

What is the function describing the theoretical erosion curve?

SMOKE POLLUTION

Ringelmann's Scale
Particle Density

Project:

A more positive approach to environmental problems may be easily utilized by the physical science - physics student. If a Ringelmann's scale is used to report on pollution violators, effective action can result. The Ringelmann's scale can be used in many forms; a simple one presented in the The New York Times is presented below:

Used on a sunny day, with sun behind observer

The New York Times

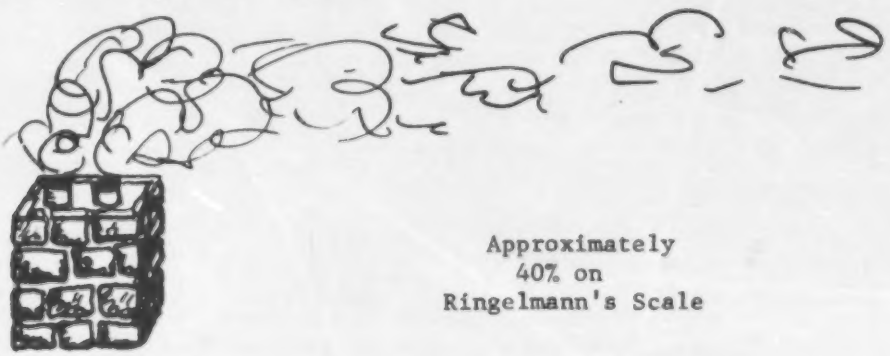
Ringelmann Scale

Use Ringelmann Scale on opposite side to measure blackness of smoke

(sign name here)

Used on the smoke immediately issued from stack or source

It is used for grading the density of smoke from any source. The percentages refer to the amount of area black. The scale is held at arm's length and judgment of the pollutor is made. Now, with a small paper scale the level is checked off on the scale. Then the scale and a letter describing who and where the violator is is sent to the local city council or what ever agency is responsible for air pollution control. This is were the action comes in. The pollutor may be an industry, large or small, and even a state project. Many individual homes burn oil ineffectively - they can be reported. Apartment houses are often gross contributors to air pollution, as are incinerators, tepee burners and dumps. The problem sources should be judged for quantity as well as the intensity of the smoke.



Approximately
40% on
Ringelmann's Scale

POPULATION, STANDARD OF LIVING AND NATURAL RESOURCES 14

Roy C. White

Introduction

Population growth and ever-rising production is an illusion from which the world may now be awakening, because its elements are mutually insupportable in a finite world with limited resources. Today a new relationship prevails between wealth and population. The richer a society aspires to become, the fewer additional people it can support in conditions of freedom and health. We cannot be certain that a new generation of technological triumphs will not provide a growing world population with materials and energy at a low level of environmental damage. But the record of the recent past is sobering. Man's technological skills have grown steadily, yet pollution and the disruption of natural cycles have mounted year by year, spreading from local crisis areas to encumber the whole planet.

Data for Students

Human population growth rate in the United States is calculated at one percent per year (1970). This one percent increase in human population, if continued for 70 years, will result in a doubling of the U.S. population by the year 2040. The world's population growth rate is estimated at about two percent per year which will result in a doubling of the world population, if this rate of growth continues, in 35 years. (USA population = 204 million in 1970; world population = 3.6 billion in 1970).

Energy consumption is a reliable gauge of a society's economic status. The United States produces and consumes nearly three times as much electrical energy per person as any other continental region. It has been estimated that the energy consumption for the United States, if present trends continue, will be about 2.7 trillion KWH in 1980.

Non-renewable natural resources are present on the earth in fixed amounts.

Objectives:

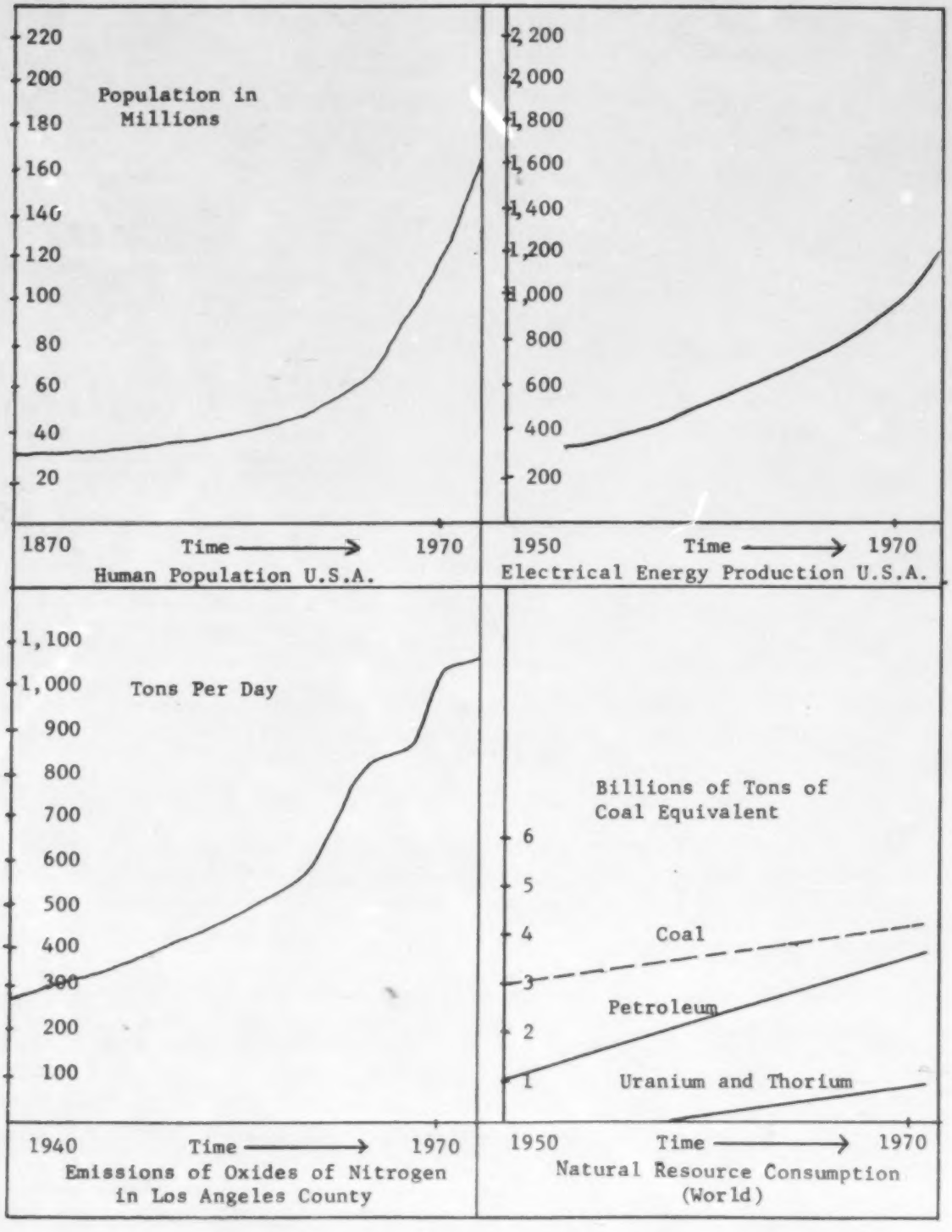
Students should become familiar with the reality that population increases in an affluent society will be limited by available natural resources, if that affluence is maintained.

The students should become aware that social action is necessary if a balanced relationship is achieved between resource consumption and standard of living.

The students should realize that even if pollution problems are solved that continued population increases place increasing demands upon limited natural resources.

Student Directions:

Observe the four graphs below. What relationship exists among these four graphs?



Teaching Strategies:

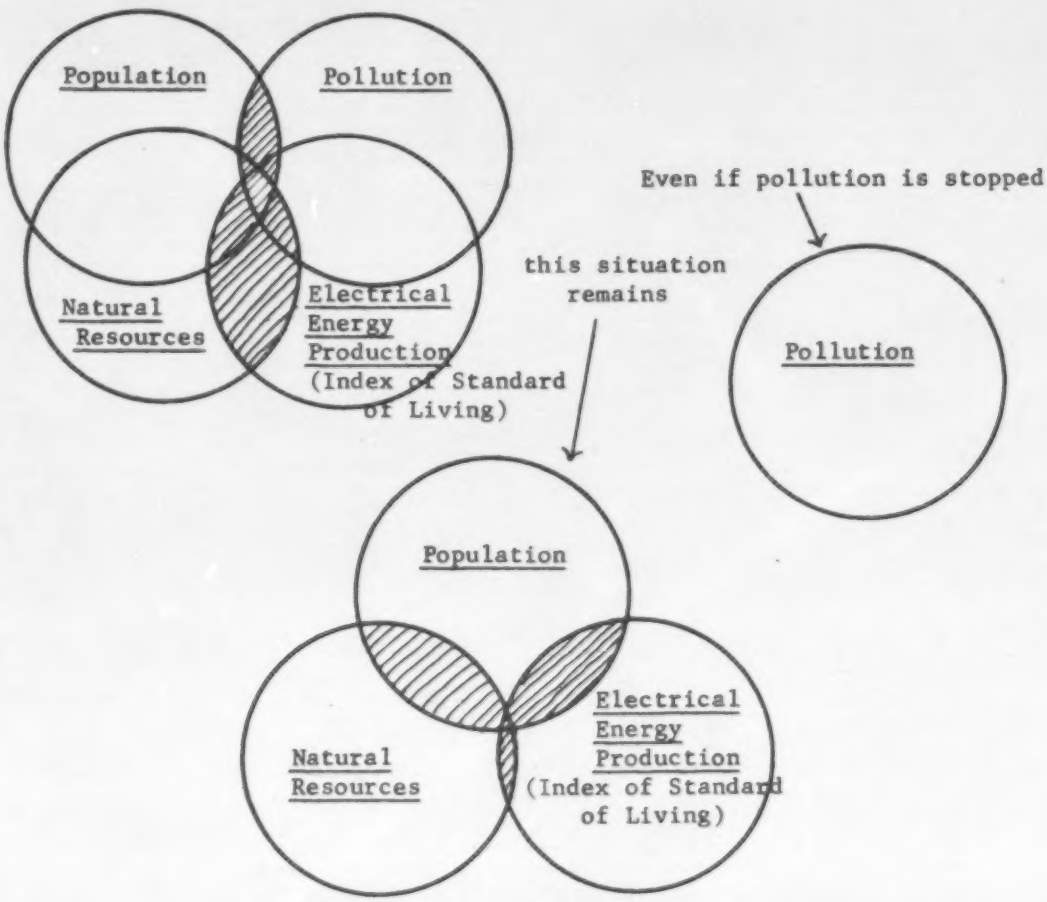
This exercise should involve the cognitive behaviors of identifying elements for analysis, displaying and synthesizing observations, interpreting data, predicting consequences, extrapolating, analyzing of relationships and forming inferences.

It should involve the affective behaviors of reality orientation, responsibility, consensus and collaboration.

It could be used as an introduction to the conceptual scheme involving the following principles: 1) There is a limit to the earth's carrying capacity. 2) The standard of living for people ("Quality of Life") is controlled by the amount of natural resources available to each individual in the population. 3) Numbers 1 and 2 are present even if pollution of the biosphere is stopped, urban-societal problems are resolved and the threat of nuclear war is eliminated.

The students should be able to develop the following conceptual scheme:

Present Situation (1970)



Evaluation:

The teacher may subjectively evaluate the students' ability to synthesize observation, analyze relationships, interpret data, and extrapolate information. If the students offer solutions to the population, natural resources, standard of living syndrome the teacher must not impose his own value system upon the evaluation of the students' solutions.

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SOME ENVIRONMENTAL-MATHEMATICAL CONCEPTS

Bill Hammer

15

Introduction

What is the significance of human population increase, resource consumption and exponential growth? Consider two factors--the earth's human population and the consumption of natural resources, i.e., minerals, fuels and living space, which are growing exponentially. It is worthy to note that the use of resources is not merely keeping pace with the population, but that it is growing several times faster than the population. This rapid growth of both population and consumption of resources is not without its adverse effects. Environmental degradation in all forms: air pollution, water pollution, destruction of human and wildlife and crowded living conditions in urban areas are some of the adverse effects of this rapid growth.

The significance of the human population, resources and exponential growth lies with us now and with us in the future. Can the human population continue to grow exponentially forever? Whose responsibility is it to halt the growth? Can the consumption of resources increase forever in a world where resources are finite? Whose responsibility is it to begin using less? Is it our children's responsibility? Or is it our responsibility?

The following quotation points out danger to many concerned persons.

> "Should our population continue growing, even at the present 'declining' rate, it would double in about another four decades and double again in less time than that."[1]

This prediction of our future population is founded on mathematical projections involving the current population and its growth rate. We might be wondering if such projections are accurate. How do we know what the growth rate will be in the future? Is a three-fold increase in population possible in my lifetime? These questions and others can be better answered with a knowledge of the mathematics involved in making these projections.

FUNDAMENTAL EQUATIONS

The derivation of the fundamental equations for mathematical projections relating to exponential growth follows:

$$P_t = P_o (1 + a)^t \qquad \text{Equation 1}$$

where P_o is the initial population

P_t is population after t years

t is the number of years of growth

a is the growth per year, expressed as fraction of the population at the beginning of the year

(A is the growth per year, expressed as % of the population at the beginning of the year.)

Equation 1 may also be written, by taking logarithms on both sides,

so $\log_e (P_t/P_o) = t \log_e (1 + a)$. Equation 2

In common logarithms, it becomes $\log_{10} (P_t/P_o) = t \log_{10} (1 + a)$.

$\log_e (1 + a)$ may also be expressed as a series:

$\log_e (1 + a) = a - a^2/2 + a^3/3 \cdots$ Equation 3 (Approx.)

For approximate purposes, if a is less than about 0.1, all but the first term may be ignored and

$\log_e (1 + a) = a$ Equation 4 (Approx.)

whence $\log_e (P_t/P_o) = ta$ Equation 5 (Approx.)

and $\log_{10}(P_t/P_o) = ta/2.303$ Equation 6 (Approx.)

The time for a population, growing according to equation 1, to double, t_2, comes from equation 5 by setting $P_t/P_o = 2$:

$\log_e(2) = t_2 a$, but $\log_e(2) = 0.69$,

so $t_2 = 0.69/a$. Equation 8 (Approx.)

If we express the growth in %, then

$$\boxed{t_2 = 69/A}$$ Equation 9 (Approx.)

For a 3-fold growth, in corresponding fashion,

$$\boxed{t_3 = 110/A}$$ Equation 10 (Approx.)

and for a 10-fold growth

$$\boxed{t_{10} = 230.3/A}$$ Equation 11 (Approx.)

From equation 1 any problem dealing with exponential growth can be solved.

Derived equations 9, 10 and 11 are specific for situations where 2-, 3- and 10-fold increases are the case.

Problems:

1. If a population grows at 2.3%/yr, how long will it take for it to double? to treble? to increase ten-fold?
2. At 3.5%/yr, how long will it take for it to double?
3. At 6.9%/yr, how long will it take for it to double?

4. How long to quadruple at each of the three above growth rates?
5. Suppose a population of 1 million (1mm) grows at 1.15%/yr. What will it have grown to after 200 years?
6. If a population doubles in 17 years, what is its growth rate? Assume that it grows according to equation 1.
7. If a population doubles in 10 years, how many times its original number will it be after growing for the following periods: 10 years, 20 years, 30 years, 40 years, 50 years, 60 years, 70 years, 80 years, 90 years, 100 years
8. If a population increases 10-fold in 33 years, how many times its original numbers will it be after the following periods: 33 years, 66 years, 99 years
9. If a population grows at 2.3%/yr, how long will it take for it to grow 10-fold?
10. If a population grows a million-fold in a thousand years, according to equation 1 (that is, exponentially), what is the growth rate per year?
11. If a population grows at 2.3%/yr, how long will it take for it to grow 6-fold?

Answers to population growth problems:

1. 30 years, 48 years, 100 years
2. 20 years
3. 10 years
4. 60 years, 40 years, 20 years
5. 10 million
6. 4% per year
7. 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, (or, roughly, 1000)
8. 10, 100, 1000
9. 100 years
10. 1.4% (if it grows a million-fold in a thousand years, it grows 10-fold in a sixth of that time, or 167 years; to grow 10-fold in 167 years, requires a growth rate of 1.4%: 230.3/1.4 = 167)
11. 78 years (30 years to double plus another 48 years to treble)

It is important to note that the same equations, with minor substitutions, can be applied to any phenomenon which exhibits a growth rate expressable as a percent of the total.[2] For example, demand for electrical energy is growing by about 9% annually.[2] What is the doubling time for electrical energy demand? To solve this problem, equation 9 can be used in the following manner.

$t_2 = \frac{69}{A}$, where A is the growth per year expressed as a percent of the electrical demand at the beginning of the year

$t_2 = \frac{69}{9\%}$

$t_2 = 7.67$ years, the doubling time for electrical energy demand.

RESOURCE CONSUMPTION

Geologists have determined the probable amounts of economic mineral deposits which remain to be mined from the earth. The reserve of a mineral partially depends on the economics of the mineral, and thus on the technology involved in extraction and processing. In the past dramatic technological steps have occurred; however, developments in the utilization of low grade ores, wise use of energy and re-use or recycling are slow in coming.

The problem of determining the life of a reserve depends on a multitude of dynamic factors. At best, the life expectancy of a mineral resource is an approximation involving a particular set of criteria at a particular time.

In problem four of the resource consumption group, the total reserve is 84×10^9 barrels. The reserve is being consumed by 3×10^9 barrels per year and this rate of consumption is growing by 5.5% per year. To determine the life of the reserve involves logarithms or addition-multiplication arithmetic. Calculation of the answer applying the latter method follows:

The first year's consumption rate is 3×10^9 barrels per year, thus the first year's consumption is 3×10^9 barrels.

After the first year, consumption has grown by 5.5%, that is $(.055 \times 3 \times 10^9) + 3 \times 10^9$ to 3.16×10^9 barrels per year. By adding the first year's consumption of 3×10^9 barrels to the second year's consumption of 3.16×10^9 barrels, we arrive at the amount consumed after two years, 6.16×10^9 barrels.

Consumption during the third year also grows by 5.5% and is now 3.33×10^9 barrels per year $(.055 \times 3.16 + 3.16)$. The total amount consumed after three years is now $3.33 \times 10^9 + 6.16 \times 10^9$, or 9.49×10^9 barrels.

This is carried on until the total consumed is equal to the original reserve. A somewhat faster method is to plot the amount consumed on the Y-axis of coordinate paper and the years on the X-axis. After several years have been plotted, the approximate shape of the curve will be evident and the final answer can be estimated.

Problems:

1. What is the doubling period for the United States' production of coal at the exponential growth rate of about 7% per year?

2. What is the doubling time for the world's consumption of energy if the consumption rate continues to increase at 4% per year?

3. If United States crude oil production stabilizes at 3×10^9 barrels per year, how long will reserves of 84×10^9 barrels last?

4. The best 1968 estimate of all remaining crude oil reserves in the conterminous United States is 84×10^9 barrels.[3] At the 1964 production rate of approximately 3×10^9 barrels per year, growing at 5.5% per year, how long will the remaining crude oil last?

5. What is the life of natural gas reserves of 276,000 billion cubic feet if the consumption growth rate is approximately 5% per year and marketed production was approximately 15,464 billion cubic feet per year in 1964?[4]

6. The free world total reserves of uranium oxide (uranium ore) is 621,000 tons.[5] Domestic civilian demand for uranium oxide in 1970 was approximately 2,500 tons.[6] What is the life of the total free world reserves at a consumption growth rate of 6% per year?

7. United States and Canadian estimated recoverable reserves of coal in 1964 was 862,203 million short tons. United States and Canadian production of coal in 1964 was 507,665 thousand short tons,[7] a production growth rate of 7% per year. What is the expected life of these reserves?

Graphic presentations of exponential growth may assist in conceptualizing some environmentally related information. Depletion of resources is easily illustrated with pie-shaped charts while the graph of a logarithmic curve portrays exponential growth. Use imagination in this area!

Public health departments in some communities monitor the air daily for pollution. Whether particulate material or gases are measured, their levels of concentration can be illustrated in a variety of creative ways. For example, graphic illustrations of micrograms per cubic meter of particulate materials can be shown by the histogram or bar graph. Pollution levels may be arranged on the vertical Y-axis while the days of a month may be placed on the X-axis. Drawing a line across the graph at the desired maximum or safe level adds dimension to the illustration.

A state department of health has estabilised that the maximum allowable flouride content in animal forage will be 35 ppm (parts per million) on a dry weight basis. The health department also has established that the air we breathe will contain no more than 1.0 ppb (parts per billion) for any 24-hour period.[8]

The preceding paragraph is an example of regulatory standards and laws which are designed to control the amount of contamination in our food, air, water, and living space. Such measurements and standards depend to a great degree on the concepts of ppm and ppb.

Parts per million and parts per billion are both expressions of the relative quantity of a substance in a much larger quantity of something else. In the sense that ppm is a relative value it is similar to percentage. In fact, one ppm can be converted to a percent value by the following operation:

1 part per million is how many parts per 100.
% really means part per 100 parts.
Hence 15% really means 15 parts per 100 parts.

$$N = \%$$

$$\frac{N}{100} = \frac{1}{1,000,000}$$

$$N = \frac{1}{10,000}$$

$$N = .0001\%$$

Thus 10,000 parts per million is 1%

$$\frac{N}{100} = \frac{10,000}{1,000,000}$$

$$N = \frac{1,000,000}{1,000,000} = 1\%$$

Field or laboratory work commonly involves samples of material of 1.0 gram. In a 1 gram sample 1 ppm is one millionth of a gram or one microgram. In volume measurements, 1 ppm is one microliter per liter, in weight-volume

terms 1 ppm equals 1 milligram per liter.

In terms of quantities which can be visualized easily, one drop of food coloring in a 16.28 gallon aquarium is approximately 1 ppm. (60 drops/fluiddram, 8 fluid drams/ounce, 480 drops/ounce, 128 oz./gal., 61,440 drops/gallon.)

Would one ppm red food coloring turn 16.28 gallons of water red? One ppm of something doesn't sound very impressive, yet in many cases it is lethal.[9] For instance, 0.00005 ppm of DDT can kill newly hatched crab larvae. The insecticide Parathion's LD_{50} for white rats is 8.0 ppm. LD_{50} is the lethal dose for 50% of the experimental population. The LD_{50} for the insecticide Aldrin is 40.0 ppm for white rats.[10] Approximately 2.4 ppm mercury was present in the red blood cells of people showing definite symptoms of mercury poisoning.[11]

DDT, mercury, fluoride, and other pollutants are not necessarily excreted from an ingesting organism's body at the same rate as it enters. DDT accumulates in fatty tissue,[12] mercury accumulates more in the kidneys and liver,[13] while fluoride accumulates in animal bones and teeth and in the foliage of plants.[14]

Graphically illustrate the following phenomena: (F = Flourine)

Bean plants in a controlled experiment were exposed to airborne concentrations of 10.1 ppm F for 3,6 and 10 days. The plants exposed for 3 days accumulated 586 ppm F, the plants exposed for 6 days accumulated 681 ppm F, and the plants exposed for 10 days accumulated 827 ppm F.[15]

Red clover and timothy foliage plants were exposed to concentrations of F averaging 9.0 ppb. Within three days more than 100 ppm F had accumulated in the foliage and after 14 days 400 ppm had accumulated.[16]

Determine the potential concentration of chlorine residual in milligrams per liter (ppm) down-river from a city sewage disposal plant for the months of May and August. The river flow in May in cubic feet per second is 11,190, while in August the flow is 1,740 cu. ft./sec. The sewage flow in May averages 4,155,000 gallons per day, and in August, 3,963,000 gallons per day. The average chlorine residual in the sewage is 0.4 mg/l.[17] If 50 cities situated along the river from its head to its mouth contribute similar quantities of chlorine, what is the potential concentration of chlorine in ppm? What is the dilution of the total amount of treated sewage in the river for May and August from one city?

In August, 6,052 pounds of chlorine were added to the sewage effluent to control pathogenic bacteria. The chlorine residual (0.4 mg/l) doesn't account for this amount. How much chlorine is absorbed by the effluent before the 0.4 mg/l residual is established?

The phosphate load of the river upstream from the sewage plant effluent is approximately 0.30 ppm, while the phosphate load of the sewage effluent is approximately 10.5 ppm. In August, how many pounds of phosphorus are added to the river each day by the sewage effluent? What is the source of phosphorus in the sewage effluent?[18]

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INCORPORATION OF ECOLOGICAL-ENVIRONMENTAL CONCEPTS INTO A U.S. GOVERNMENT COURSE

16

Kerry Doran

"Such as is the air, such be our spirits, such are our humours."---

Robert Burton, (1577-1640) from Anatomy of Melancholy.

Introduction

How can environmental education be incorporated into a course in United States government? Several important segments within the curriculum have been selected as the most advantageous and compatible. Each broad area selected will contain the following information: a statement of understandings to be arrived at, selected concepts and facts, suggested teaching procedures and activities, instructional materials and an explanation of how the environmental and ecological information could be incorporated into the particular area being examined. Each area is by no means complete but should be expanded upon while being taught.

United States Government:

Area 1 Democracy and the Free-Market Economy

Understanding: (1) A free-market economy operates within the U. S. democratic society. (2) Effective national measures for enhancing environmental quality must be based on knowledge about the complex and interacting economic processes that underlie pollution, rather than on the popular assertion that population growth alone is to blame.

Selected Concepts: freedom of choice, free-market economy, pollution, ecology, environment, capital, competition, consumer goods, consumption economy, scarcity, capitalism, private property, anti-trust laws, supply and demand, and utility (the economic concept of choice).

Suggested Teaching Procedures: Read chapter 3 in American Government in the 20th Century, by William Ebenstein and read selections from Resources and Man, by the National Academy of Sciences. Have the students conduct a study to find out what products being sold within the town are contributing to pollution, how to make the community aware of these products and how to discourage the buying of such products.

Discuss the following questions in conjunction with the above reading:

1. How might a nation achieve a higher rate of economic growth? What effect will this have on the environment?
2. What motive induces men to learn new methods and/or develop new resources?
3. What happens to the production of a company, or of an individual, when they cease to produce what the public wants?
4. How are the problems of what to use and where to use it to be solved in a democratic, capitalistic society?

5. The psychology of advertisement in conjunction with public demand.

Instructional Materials: (1) Berle, Adolf, The American Economic Republic (2) M.I. Goldman ed. Controlling Pollution: The Economics of a Cleaner America (3) Record - Pete Seeger's, "God Bless the Grass."

Environmental pollution in the U. S. today is determined by a high per capita consumption based on high per capita income, conbined with a sophisticated and powerful technology. Many people condemn "the system," for the problem, which includes economic and political organizations and modern man. Unless the producer who advertises environmentally harmful items is matched by a purchaser who is willing to be persuaded, no untoward consequences will emerge. Our economic structure is based on a market system using costs, prices and profits as guides to resource allocations. Any organizing principle of production other than one that explicitly assigns a value to environmental factors will tend to use these cost-free aids of production so intensively that eventually symptoms of excessive use appear - namely pollution. The imposition of charges high enough to compensate for environmental damage would stimulate a search for a technology that would help the corporation reduce pollution. A similar system could be established for individuals to discourage their polluting of the landscape.

Area 2 Federalism

Understandings: (1) There is a separation of posers between the federal and state governments. (2) The problem of environmental pollution cannot be solved by state governments alone. (3) The problem of pollution must be attacked from all levels of government.

Selected Concepts: elastic clause, concurrent powers, delegated powers, grants-in-aid interstate, intrastate police power, McCulloch vs. Maryland, U.S. Corps of Engineers, Water Quality Act 1965, Clean Air Act 1963.

Suggested Teaching Procedures: (1) Read Chapter 6 in American Government in the 20th Century. (2) Read appropriate sections in the U.S. Consitution. (3) Read the 1955 Act by Congress authorizing HEW to assist state and local agencies with pollution control. (4) Read the Clear Air and Water Quality Acts by Congress. (5) Read President Johnson's Message on Conservation, 1966.

Discuss the following questions:

1. Why is the federal government becoming increasingly involved in the struggle for open space, beauty and cleaner air and water?
2. Should the federal government step in if a state is unable or unwilling to undertake programs that the federal government feels are necessary for the good of the citizens of the state? (concentrate in the area of pollution)

Projects:

1. Find out which federal programs are in effect in your school.
2. Make a study of the states' efforts to curb wastes and air pollution. What percentage is paid for by the state? By the federal government?
3. Examine the ways in which Soil Conservation Service, Bureau of Reclamation, National Park Service, etc. assist local agencies.
4. Make a study of ways in which the local community can obtain more federal aid to combat pollution.

Instructional Material:

1. A Place to Live: The Yearbook of Agriculture - 1963.
2. Write Montana State Health Department for information on federal aid for pollution control.
3. Films and teaching materials from Department of Interior.
4. Nash, Roderick, ed. The American Environment: Readings in the History of Conservation.

In the early 1900's two government agancies began to play important roles in conservation. The Department of the Interior was established in 1849, and in 1862 the Department of Agriculture. Both cooperate with state and local agencies to promote conservation. In 1934 Congress passed the Taylor Grazing Act which set up a system of controlled grazing to protect public ranges from overgrazing and erosion. A series of disastrous floods in the 1920's and 1930's induced Congress to enact the Flood Control Act of 1936 under which the federal government and the states acted to protect the lower Mississippi Valley.

More recent examples of cooperation between the federal and local governments have been the appropriation of $1 billion a year to build treatment plants for raw sewage.

The failure of state and local governments and of private industries to solve water pollution has led to increasing federal involvement. This has included research, federal aid for construction of sewage treatment facilities, and federal-state cooperation in planning for pollution control. Eight states joined the federal government in forming a Great Lakes River Basin Commission to study pollution in the Great Lakes and to draft a plan for dealing with the problem. The Water Quality Act of 1965 strengthened the role of the federal government by increasing the powers vested in a new division of HEW.

By its very nature air pollution is a problem that freely crosses many political boundaries. As a result people have quite naturally looked to the federal government for help. The Clean Air Act of 1963 is attempting to deal with this problem.

The Land and Water Conservation Fund created by Congress in 1964 provides funds on a matching basis to states for planning, acquiring and developing state and local outdoor recreation areas.

Area 3 Interest Groups

Understandings: (1) Interest groups play an important role in the democratic process. (2) Much of the proposed legislation for conservation and pollution control has been defeated or diluted due to the action of interest groups on the state and national level.

Selected Concepts: interest groups, lobbyist, lobby, pressure group, collective bargaining, National Tuberculosis and Respiratory Disease Association, Hugh More Fund, National Heart Association, National Geographic Society, Resources for the Future, Inc., Shell Oil on the American Petroleum Institute, Sierra Club, Farmers Union and Chamber of Commerce.

Suggested Teaching Procedures: (1) Read Chapter 14 in American Government in the 20th Century.

Projects:

1. Conduct class poll at the beginning of the semester to determine public position on pollution. Conduct another poll at end of semester, after class has tried to inform public concerning pollution, to determine if there has been any change in public position concerning pollution.
3. Write letters to the National Tuberculosis Association to gather information on lobbying activities.
4. Write letters to congressmen in support of pollution control legislation.
5. Direct the students' interest to researching and discussing industries and other interest groups involved with lobbying. An example would be an oil company which produces petroleum products and pesticides, and contrast their activities (political) with the activities of the Sierra Club, National Wildlife Federation and League of Women Voters.

Discuss the following: 1. Identify the factors that contribute to the effectiveness of interest groups. 2. Organized interest groups have been responsibile for much of the pollution control legislation.

Instructional Material:

1. Monsen, R. Joseph, The Makers of Public Policy: American Power Groups and Their Ideologies.
2. Udall, Stewart, The Quiet Crisis.
3. Pamphlets from organizations involved in lobbying for pollution control and conservation.

In our society there are few cases in which legislation has been passed without some pressure brought to bear on congressional leaders. Such are the activities of lobbyists. Every major organization in this country has paid lobbyists in Washington and state capitols to secure legislation beneficial to or in accord with the philosophy of the organization.

Individual citizens can influence the course of conservation in many ways, directly and through representatives in government. Anyone can belong to a conservation group and share in its activities. Property owners and tenants can try to maintain land and buildings in sound, attractive conditions. Farmers and businessmen can practice conservation techniques appropriate to their enterprises. All of us can inform ourselves about conservation and pollution control and express our opinions to the government officials who make the decisions and who act upon them. To put it another way, the aim is to develop amateur lobbyists.

Area 4 Congress in Action

Understandings: (1) Congressional legislation is the product of a much involved process in both houses of Congress. (2) In order to promote conservation and pollution control Congress must provide sound legislation dealing with these problems. (3) If pollution is to be dealt with successfully, Congress must act in the postion of an innovator rather than a reactor.

Selected Concepts: calendar, item veto, pocket veto, quorum, seniority, compromise, rider, roll-call vote, veto, conference committee, conservation legislation, Wilderness Preservation Act, 1964, Land and Water Conservation Fund 1964, Clean Air Act of 1963, Water Quality Act 1965, Environmental Education Act, 1970, Environmental Protection Agency, 1970.

Suggested Teaching Procedures: (1) Read chapter 18 in American Government in the 20th Century. (2) Read the Clean Air Act of 1963 and Water Quality Act 1965. (3) Read appropriate sections of the U.S. Constitution dealing with legislation

Projects:

1. Write a bill dealing with pollution (in conjunction with the science department) and follow the legislative steps of Congress. Then forward a copy of the bill to our congressmen. Contact local agencies dealing with conservation for assistance.
2. Trace the records of the congressmen on pollution legislation. Write letters in support of pollution control legislation.
3. Campaign for local government leaders who are working for pollution control.
4. Take colored slide pictures of particularly ugly or beautiful spots in the community. Include auto graveyards, billboards, badly eroded areas, and especially the local waterways; include attractive new buildings, parks and areas of unspoiled natural beauty. Give an illustrated talk to local governmental leaders and organizations on "Conservation Begins at Home."

Discuss the following: (1) A legislator is often torn between his three masters: his conscience, his constituents and his party loyalty. In your opinion which is most important? (2) What can students do to secure more effective pollution legislation?

Instructional Material:

1. Information from Senate and House committees dealing with pollution.
2. Clepper, Henry, ed. Origins of American Conservation.

Congress has taken many steps to enact legislation dealing with the problem of pollution. All too often it has been too little, too late. The government must take steps to offer economic incentives to provent pollution. Tax laws could be revised to make it easier for companies to invest in equipment to reduce pollution. Fees chould be charged against those who cause pollution. In the Ruhr Valley of West Germany, for example, a charge is levied on every municipality and industrial plant in proportion to the pollution it causes. Uniform national laws would put competing industries on an equal basis, make pollution control part of the normal cost of doing business, and encourage industries to develop means to reduce pollution.

Area 5 The President, the Cabinet and Executive Agencies

Understandings: (1) The President is assisted in his work by many Cabinet positions and agencies. (2) The Departments of the Interior and Agriculture, and HEW play an important role in conservation and pollution control.

Selected Concepts: Conservation, Civil Service, quasi-legislative bodies, Cabinet, executive agencies, TVA.

Suggested Teaching Procedures: (1) Read chapter 20 in American Government in the 20th Century.

Projects:

1. Make a study to see how many of President Johnson's recommendations

from his message on conservation of 1966 were adopted.
2. Make a careful study of the TVA. Note the social and economic effects of this program upon the valley and its people.
3. Make a study of local and state agencies to determine what they have done to combat pollution.

Discuss the Following: (1) What is our community doing to provide adequate parks and recreation areas for the future? (2) What control, if any, does the public have over the independent agencies? (3) How powerful, especially in the area of conservation, should they be allowed to become? (4) Is it the influence of the President that determines national priorities? (5) What determines the setting of national priorities? (6) Should the employees in the numerous state and federal agencies be held accountable to the public? (7) Who regulates the actions of government employees?

Instructional Material:

1. Films and teaching material from Fish and Wildlife Service.
2. Fenno, Richard, The President's Cabinet.
3. Information from the Cabinet and agencies dealing with pollution.

Today the government of the United States deals with many far reaching and complex problems. The President alone could never begin to deal effectively with them. This is why the Cabinet and executive agencies were created. Each one acts as an authority in its own area to assist and advise the President. The Department of the Interior, created in 1849, is responsible for formulating and administering programs for the management, conservation and development of the natural resources of the United States. The Secretary of the Interior is in charge of a vast array of activities aimed at the protection of our natural resources. The major agencies of the Department of the Interior are: (1) Fish and Wildlife Service, (2) National Park Service, (3) Bureau of Indian Affairs, (4) Bureau of Reclamation and (5) Federal Water Pollution Control Administration.

Area 6 Financing Our National Government

Understanding: (1) A budget is a government estimate of income and outgo for a predetermined period. (2) Large sums of money are being spent, and still more need to be spent by private and public agencies to clean up the environment. (3)Continued pollution will cost the public more money in increased taxes.

Selected Concepts: litter, photochemical smog, desalting projects, radioactive wastes, balanced budget, deficit, fiscal year, income tax, national debt, revenue.

Suggested Teaching Procedures: (1) Read Chapter 22 in American Government in the 20th Century. (2) Read sections of Natural Resources for U.S. Growth: A Look Ahead to the Year 2000, by Landsberg, Hans.

Projects:

1. Examine the local town budget to determine how much money is being spent by the community for pollution control purposes.
2. Run fund raising projects so that money can be donated to pollution control and environmental cleanup of the community.
3. Relate standard of living, population, resource consumption and pollution to each other.

Discuss the Following: (1) Should emphasis on various categories in the federal budget be shifted? Which should be increased in importance? Which should be decreased? What new programs should be developed? Which current programs should be curtailed or abolished? (2) Who should pay for pollution control and conservation?

Instructional Materials:

1. Write to the Bureau of the Budget and the General Accounting Office for information.
2. Write to local conservation organizations to determine how much they are spending on pollution control.
3. Read Wildavsky, Aaron, The Politics of the Budgetary Process.
4. Write to the Federal Reserve Bank of Philadelphia for "Balance of Payment."

Despite private industry's estimated current spending of about 300 million dollars annually on pollution control, much more needs to be done. Government estimates place property damage from air pollution at $11 billion a year, not counting the probable decline in some real estate values. A University of California scientist stated in 1965 that known crop losses due to air pollution in California amount to $12 million a year. The estimated cost of cleaning up our streams is as much as $75 billion for the next 20 or 30 years. Despite expenditures of about 5 billion dollars for flood control since 1936, average annual flood losses have more than doubled since then.

In 1966, grants totaling $3.4 billion were authorized by Congress for 1968-71 for water pollution control. The tax reform bill recently passed by Congress would provide for five-year tax amortization of pollution control facilities and, according to recent testimony, would cost the government $400 million a year in foregone revenues.

In less than two years federal assistance has stimulated a 50 percent increase in the air pollution budgets of state and local governments.

Large sums of money are being spent on pollution control but much more is needed to correct the pollution problem.

"MAN AS A HUMAN ANIMAL"--A Model Unit for High School Environmental Education

Gary Hall

17

Introduction

The following are sample units adaptable to any high school general or advanced biology course. The major emphasis is on the ecological basis of the environmental crisis. The various units are developed on a conceptual theme leading to the culminating unit, "Man as a Human Animal." The course outline is designed specifically for the integration of three essential aspects of any environmental program, (1) awareness (2) concern (3) involvement. The unit is described in detail so that it can be used as a model for designing future environmental studies in secondary school biology. It includes methods, materials and teaching techniques to meet the needs of advanced as well as "less able" students. Every effort is made to individualize instruction. In addition, an interdisciplinary approach to the environmental program is utilized. This may necessitate team teaching and/or the integration of resource personnel and professionals into the unit.

The unit is designed to stimulate ideas and criticisms and will be revised and adapted by teachers desiring to meet specific needs of students throughout communities in Montana.

I. How Can Biological Concepts Function in Man's Development of an Ecological Conscience?

II. Units Within a Year's Course of Study:

A. Introduction - The Nature of Ecology

B. The Ecosystem and the Community
   1. Energy flow and material cycling
   2. Environmental influences
   3. Periodicity and biological clocks
   4. Succession

C. Aquatic and Terrestrial Habitat
   1. Water as a medium for life
   2. Lakes, ponds, marshes, bogs
   3. Flowing water
   4. The seashore, estuaries
   5. The soil
   6. The grasslands
   7. The desert and shrublands
   8. The forest
   9. The tundra
   10. Distribution of communities

D. Population Ecology
   1. Relationships within a population
   2. Relationships between populations

E. Natural Selection and Speciation
   1. Basis of natural selection
   2. Species and how they arise

F. The Behavior of Animals
   1. Behavior, some basic considerations
   2. Egocentric behavior
   3. Social behavior

G. Man As A Human Animal
   1. History of life
   2. Man and cultural evolution
   3. Man's interactions with biological systems
   4. Ecotactics

III. Ecology has been defined many times and in several ways. The underlying theme of these definitions is the interrelationships of all living things with their biophysical environment (ecosystem). Since man is a living thing, a social animal, a biological entity, it is imperative that he realize he is an integral part of a system from which he cannot be separated. Specifically, this system consists of three components: man, culture and the biophysical environment. The fundamental relationships between the integral parts of the system is man's interaction through culture on the biophysical environment to produce or obtain the goods and services he needs. Within this system man has the ability to either strengthen, weaken or maintain the interrelationships between the system's major components.

Man must develop an ecological awareness that will ultimately result in a high quality system that coincides with the advancement of human welfare. Further, man must develop an ecological conscience that will guide his decisions and policies concerning past, present and future cultural and biophysical interactions.

IV. Objectives

A. Direct knowledge: Students who have studied this unit should have increased knowledge and understanding of the following:

   1. General concept: Man is an inseparable part of a system, consisting of man, culture and the biophysical environment.

      Behavioral objectives: The student will be better able to:

      a. Reconstruct the geologic time scale and man's relation to it.
      b. Contrast prehistoric ecosystem stability with contemporary ecosystem instability.
      c. Contrast prehistoric habitats and niche diversity with today.
      d. Identify prehistoric causes of extinction.
      e. Differentiate between straight-line evolution and speciation based on natural selection.
      f. Discuss man's evolution to date.

   2. General Concept: Man's culture interacts with the biophysical environment to obtain his basic needs.

Behavioral objectives: The student will be better able to:

a. List and compare the basic needs of man with other animal societies.
b. Identify and list man's use of natural resources as man-made components of the biophysical environment in relation to man's cultural evolution.
c. Contrast medieval views of man and nature with contemporary views and its impact on cultural evolution.
d. Identify western tradition of technology and science and its impact on cultural evolution and the biophysical environment.

3. General concept: Biophysical environmental problems result from negative interaction between man, culture and the biophysical environment.

Behavioral objectives: The student will be better able to:

a. Identify the biological, physical and social components of contemporary problems related to human ecology.
b. Discuss man's influence on the abundance and distribution of animal and plant species and its present future implications.
c. Identify and contrast the pros and cons of pesticides in relation to the ecosystem and future human welfare.
d. Discuss contemporary conservation practices and their implications for man and the environment.
e. Relate current and future social problems with overpopulation.
f. Discuss the advantages of maintaining wild populations in their natural state.
g. Discuss the consequences of irreversibly disturbing an ecosystem.

4. General concept: The development of a man-made environment should strive for a high quality system which improves human welfare in relation to the natural environment.

Behavioral objectives: The student will be better able to:

a. Solve problems related to man and his cultural interaction with the environment.
b. Write and recite laws related to environmental problems.
c. Identify ways and methods of citizen action in working toward solutions to environmental problems.
d. Identify a community environmental problem and become involved in working toward a solution to the problem.

B. Indirect knowledge: Students who have studied this unit should have increased their appreciation and attitudes in:

1. Realizing man is an integral part of an ecosystem.
2. Realizing the aesthetic value of nature.
3. Realization and respect for the complexity of nature.
4. Realization of the importance of an ecological conscience.

C. Skills: Students who have participated in the varied activities of this unit should have developed increased skill in:

1. Developing conceptual schemes in relation to man and the environment.
2. Basic laboratory research techniques typical of environmental science.
3. Increased vocabulary in scientific terminology.
4. Discussion and organization of research materials for oral presentation.
5. Applying theory to relevant situations.
6. Reading and interpreting law and legal systems.
7. Practicing citizenship by working within the system toward solutions of environmental problems.

V. Content of Unit: "Man as a Human Animal"

A. History of Life

1. Time and Earth
   a. In the beginning
   b. Geologic epochs
   c. Fossil and historical records

2. The Nature of Adaptation
   a. Diversity of adaptations
   b. Individual adaptability

3. Natural Selection as a Historical Process
   a. Occupation of new environments
   b. Change: Persistence and replacement; complications and improvement - major adaptive radiations

4. Evolution and the Problem of Purpose
   a. The evolutionary lottery - population gene pools
   b. Historical opportunism vs. design

B. Man and Cultural Evolution

1. Basic Ecology of Homo Sapiens
   a. The human species and communities
   b. Origin and nature of races
   c. Primitive man and environments

2. Modification of Environments
   a. Cultural modification of human ecology
   b. Historical roots of our ecological crisis
   c. Urbanization
   d. Food production
   e. Business and industry

C. Man's Interaction with Biological Systems

1. Ecosystems in Jeopardy
   a. Food webs
   b. Concentration of toxic substances in ecosystems
   c. Biochemical cycles
   d. Modifying ecosystems

2. Environmental Threats to Man
   a. Pollution, noise, water, air, fluoride, radiation, lead
   b. Geological hazards
   c. The environment of modern cities
   d. Epidemiological environment

3. Overpopulation
   a. Population structure and projection
   b. Optimum population and human biology
   c. Birth control and family planning

4. Depletion and Conservation
   a. The limits of earth
   b. Utilization vs. preservation

D. Ecotactics

1. Social, Political and Economic Change
   a. Education
   b. Economic and political change

2. The Legal System
   a. Pollution laws and the legal system
   b. Congressional directory
   c. Federal agencies
   d. The activist's checklist

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a. Carson, S., "Conservation: An Attitude of Mind" Times Educational Supplement, 2,860 (March 13, 1970) p. 84.
b. Finch, R.H., "Capacity to Respond Creatively to Challenge," Nat'l Assoc. Sec. Sch. Principal Bulletin, 54 (May, 1970)
c. McCammon, L.C., "Man's Greatest Challenge, The Quest For Environmental Quality," Journal For School Health, 40 (June, 1970), p. 284-289.
d. Stapp, W.B., "Concept of Environmental Education," American Biology Teacher, 32 (Jan., 1970) p. 9-11.

D. Periodical Articles for Students

1. Selection sources
a. Biological Abstracts, Philadelphia University of Pensylvania Press, 1969. Vo. 50, p. 5, 905-906, 907.
b. Readers Guide to Periodical Literature, Wilson, 1969, p. 381-382, 412, 956-957.

2. Articles:
a. Blackham, H.J., "The Truth Should Be Out," Lanlet, 7,541 (August, 1969) p. 534-535.
b. Carter, L.J., Environmental Policy Act: Congress Passes A Landmark - Maybe," Science, 167 (Jan., 1970), p. 35-36.
c. Catton, W.R., "Decisions in the North Cascades: The Proposals as Viewed From a Sociologist," Journal of Forestry, 66 (April, 1969), p. 540-546.
d. Cornman, J.W., "Mental Terms, Theoretical Terms, and Materialism," Philosophical Science, 35 (Jan., 1968) p. 45-63.
e. Dobzhansky, T., "On Genetics, Sociology and Politics," Perspectives in Biological Med., 11 (April, 1968) p. 544-554.
f. Ennes, H., "Human Ecology," Bibliography of Vital Speeches, 35 (Jan., 1969), p. 210-215.
g. "Environmental Quality, Time for Decision." Parks and Recreation 4 (Sept., 1969), p. 33.
h. Folkman, W.S., McLaren, R.J., Christiansen, J.R., "Public Responsibility For Natural Resources," U.S. Forest Service Notes, 165, (June, 1969), p. 1-8.
i. George, J.C., "From the Brink of Extinction," National Wildlife, 7 (April, 1969), p. 200-203.
j. Henkin, H., "DDT and the Constitution, Petition to Ban DDT in Wisconsin," Nation, 208 (Mar., 1969), p. 308-310.
k. Marley, F. "Search for Clean Air," Science, 95 (March, 1969) p. 292-293.
l. Nixon's 1970 Worries, Economy and Environment," Time, 95 (Jan., 1970), p. 9-10.

m. Peet, C. "Effluent of the Affluent: Direct Legal Action Against the Offenders," American Forestry, 75 (May, 1969) p. 16-19.
n. Robinson, H.F., "Diemnsion of the World Food Crisis," Bioscience, 19 (June, 1969) p. 24-29.
o. Seaborg, G.T., "Environment and What to do About It," American Forestry, 75 (October, 1969) p. 38-39.

E. Paperback Books

1. Selection Source:
Deason, H.J., A Guide to Science Reading, New York, New American Library of World Literature, Inc., 1964. p. 130, 142, 154, 575, 591.

Paperbacks Selected:
a. Childe, V., Gordon, What Happened in History, Pelican, 1954.
b. Clark, W.F. Legros, History of Primates, Phoenis, 1957.
c. Cottrell, L., The Anvil of Civilization, Mentor, 1957.
d. Currington, Richard, A Guide to Earth History, Mentor, 1970.
e. Hardin, G., Nature and Man's Fate, Mentor, 1961.
f. Huxley, T.H., Man's Place in Nature, Ann Arbor, 1959.
g. Mair, Lucy, Primitive Government, Pelican, 1962.
h. Malthus, Thomas, Huxley & Osborn, On Population: Three Essays, Mentor, 1960.
i. Malthus, Thomas, Population: The First Essay, Ann Arbor, 1959.
j. Mead, M., Cooperation and Competition Among Primitive People, Beacon, 1961.
k. Medawar, P.P., The Future of Man, Mentor, 1961.
l. Shapiro, Harry, Man, Culture and Society, Galaxy, 1956.

2. Selection Source:
Deason, H.J., The AAAS Science Book List for Young Aaults, Wash., D.C., p. 81, 83, 101, 103, 129.

Paperbacks Selected:
a. Bates, M., The Forest and the Sea, Random, 1960.

3. Selection Source:
Olga, S.W., Paperbound Books in Print, R.R. Bowker Co., 1970, p. 8-13.

Paperbacks Selected:
a. Brower, D., Sierra Club Wilderness Handbook, Lantine, 1970.
b. Brown, H., Challenge of Man's Future, Viking, 1970.
c. Carson, Silent Spring, Houghton, 1962.
d. Carvajal, J., and Munzer M., Conservation Education; A selected bibliography, Innerstate, 1970.
e. Chambers, L.A., Guide to the Control and Appraisal of Air Pollution American Public Health, 1970.
f. Christ, J.H., Soil Conservation in the Pacific: A Symposium and a Panel Discussion, Univ. of Hawaii Press, 1970.
g. Degler, S.E., and Bloom, S.C., Federal Pollution Control Problems: Water, Air, and Social Wastes, ENA, 1970.
h. Douglas, W.O., America Challenged, Avon, 1970.
i. DuBox, R., So Human An Animal, Scribner, 1970.

j. Ehrlich, P.R., The Population Bomb, Ballantine, N.D.
k. Eldredge, H.W., Taming Megalopolis, V.I.: What Is and What Could Be. Doubleday, 1970.
l. Garrett, D.B., Environmental Handbook, Ballantine, 1970.
m. Goldman, M.L., Controlling Pollution: The Economics of a Cleaner America. P.H. N.D.
n. Hardin, G., Population, Evolution and Birth Control; A Collage of Controversial Ideas.
o. Laird, C., Pesticides and Man, Ginn, 1970.
p. LaMont, C., Environmental Crisis, Yale University Press, 1970.
q. Leinwand, G., Air and Water Pollution, W.S.P. 1970.
r. Leopold, A.W., Sand County Almanac and Sketches Here and There. Oxford, 1970.
s. Mitchell, J.G., Ecotactics: The Sierra Club Handbook for Environmental Activists, Ballantine, April, 1970.
t. Odum, E.P., Ecology, H.R. & W.N.D.
u. Paddock, W.P., Famine Nineteen Seventy-Five: America's Decision Who Will Survive, Little, 1970.
v. Perloff, H.S., Quality of the Urban Environment: Essays on "New Resources" in an Urban Age, Johns-Hopkins, 1970.
w. Shepard, P. and McKinley, D., Subversive Science: Essays Toward An Ecology of Man, H.M., 1970.
x. Storer, J., Man in the Web of Life, Signet-Nal, 1970.
y. Wengert, Natural Resources and the Political Struggle, Intl. Review, 1970.

F. Programmed Instructional Materials

1. Selection Source:
Program '63: A Guide to Programmed Instructional Materials, U.S. Government Printing Office, 1963. p. 208-210.

Programs Selected:
a. Burmester, A.M. and Lawson, C.A., Programmed Genetics, Boston, C.D. Heath Company, 1963.
b. Ginsburg, Arlene, The Age of the Dinosaurs: Life 100 Million Years Ago. Honor Products Company, Cambridge, Mass., for use in Honors Teaching Machines.
c. Whisler, Laurence, Telling Time from the Rocks, Chicago Central Scientific Co., 1963. For use in Cenco Programmed Learner.
d. Whisler, Laurence, Water as a Natural Resource. Chicago, Central Scientific Co., 1963. For use in Cenco Programmed Learner.

2. Selection Source:
Hendershop, C.H., A Bibliography of Programs & Presentation Devices Saginaw, Mich., Schner Printing Co., 1964. p. 36-40.

Programs Selected:
a. Connolly, Man and His Measure. New York, Harcourt, Brace & World, 1964.
b. Gehdi, Shaping the Earth's Surface, Rochester, Graflex, Inc., 1964.
c. McGuigan, Biological Basis for Behavior, Prentice-Hall, Inc., 1964.

d. No author cited, The Evolution of Life, Chicago, Encyclopedia Britannica Press, Inc., 1964.
e. Reynolds, Darwin's Theory of Evolution, Ball, Inc., 1964.
f. Schure, The Earth's History, Chicago, Central Scientific Co., 1964.
g. Schure, The Earth's Waters, Chicago, Central Scientific Co., 1964.
h. Tondow, Orten, Arnspiger, The Social Process Framework, Chicago Follett Publishing Co., 1964.

G. Government Documents

1. Selection Source:
Monthly Catalog of the United States Government Publications. Washington, D.C., U.S. Government Printing Office.

Sources Selected:
a. Air Pollution Abstracts, Wash., D.C., U.S. Department of Health, Education and Welfare. U.S. Government Printing Office, 1970.
b. Public Health Reports. Wash., D.C. U.S. Department of Health, Education and Welfare. U.S. Government Printing Office, 1970.
c. Interior Department Report. Wash., D.C., Department of Interior, U.S. Government Printing Office, 1970.
d. Water Resource Abstracts. Wash., D.C., Water Resources Research Center, Wash., D.C., U.S. Department of Interior. U.S. Government Printing Office, 1970. 1965-present.
e. Report of the Secretary's Commission of Pesticides and Their Relationships to Environmental Health. U.S. Department of Health, Education and Welfare. U.S. Government Printing Office, 1970.
f. Environmental Improvement. (air, water, soil) Washington, D.C. Graduate School, U.S. Department of Agriculture, 1966.

H. Sensory Aids

1. Selection Sources:
Index to 16mm Educational Films. McGraw-Hill Book Co., 1967. p. 226, 239-40, 338-40, 575.

Sources Selected: (16mm films)
a. Forest Conservation; Color, 11 min.
b. The Food Cycle and Food Chain; Color, 11 min.
c. Clean Waters; Color, 21 min.
d. Conserving Our Mineral Resources; Color, 21 min.
e. Our Proud Land; Color, 30 min.
f. Our Part in Conservation; Color, 11 min.
g. Conserving Our Soil Today; Color, 11 min.

2. Selection Source:
Learning Directory, New York. Westinghouse Learning Corporation; 1970-71. Vol. 3, p. 1921, 2193-2198, 2256-2260. Vol. 6, p. 4793-4794.

Sources Selected:
a. This Business Air; Color, 30 min.
b. Environmental Testing; Color, 10 min.

c. No Turning Back; Color, 10 min.
d. Looking Back; Color, 30 min.
e. Bulldozed America; B & W, 25 min.
f. Matter of Attitudes, A; Color, 30 min.
g. Yours is the Land; Color, 22 min.
h. Human Environment and Disease Potential; Color, 10 min.
i. The Silent Spring of Rachel Carson; B & W, 54 min.
j. Ravaged Earth, The; Color, 27 min.
k. Health Hazards of Pesticides; Color, 14 min.
l. House of Man (Our Changing Environment); Color, 17 min.
m. Cities in Crisis; A Matter of Survival; Color, 18 min.
n. Answer is Clear, The; Color, 14 min.
o. Who Killed Lake Erie? Color, 14 min.
p. Colonization of the Land; B & W, 20 min.
q. Evolution of Man; Color, 14 min.
r. Age of Man, The; B & W, 20 min.
s. Way to a New World; B & W, 20 min.

Sources Selected: (Filmstrip)
a. Survival in a Polluted Environment; B & W, 40 fr.
b. City and its Problems, The; B & W, 25 fr.
c. Introduction to Ecology; Color, 48 fr.
d. Landforms and Man; Color, 36 fr.
e. Management of Soil, The; Color, 48 fr.
f. Populations and Biomass; Color, 48 fr.
g. Seacoast Ecology; Color, 48 fr.
h. How Plants and Animals Have Changed; Color, 48 fr.

Sources Selected: (Transparencies)
a. Pollution, B & W.
b. Natural Selection and Survival; Color.
c. Geographical Distribution; Color.

Sources Selected: (Audio Tapes)
a. Chemical Pesticides: How Much a Threat to Health and the Environment? 43 min.
b. Pollution Explosion; 17 min. (Cassette)
c. Time for Ideas; Anthropology, Social Man; 25 min.

3. Selection Source:
Kene, G.A. (Editor), 8mm Film Directory. New York. Comprehensive Service Corporation; 1969-70. p. 124-233.

Sources Selected: (8mm films)
a. Land Biome of the World Series; Color, 4 min. ea.
b. Water Cycle Series; Color, 4 min. ea.
c. Lemming Migration; Color, 4 min. ea.
d. Food Getting Series; Color, 4 min. ea.
e. BSCS Biological Techniques Series; Color, 4 min. ea.
f. Balance of Nature Series; Color, 4 min. ea.

4. Selection Source:
National Center for Audio Tapes, Catalog, U. of Colorado Boulder, Colorado; 1970, p. 62-77.

Sources Selected: (Audio Tapes)
a. The Fifty Ton Gods - 15 min.

b. The Man Who Changed the Earth - 15 min.
c. Air Pollution Part 1-7, 10-15 min.
d. Paleobiochemistry; Living Process in the Past - 34 min.
e. Genetics: The Past and the Future of Living Materials - 41 min.
f. Origins of Life - 27 min.
g. The Aged Earth - 15 min.
h. Water - Or Your Life - 15 min.
i. Record of the Dead - 15 min.

VII. Activities

A. Initiatory Activities

1. A teacher meeting is held with all paraprofessional and professional personnel to be involved in the unit.
   a. Instructional Materials Center personnel.
   b. Team teachers.
   c. Paraprofessionals/Technician, Teacher Aides, etc.

   Unit content and resources are discussed and preliminary unit assignments are made. General discussion relative to unit objectives, resources available, and time schedules are considered.

L/S 2. A conference is held with students to discuss the unit. Brainstorming sessions provide suggestions as to how the unit content can be made more relative to student needs. For example, expressed student interests in community or local environmental problems is considered and incorporated into the future unit plans. Student suggestions on resource speakers, field trips, etc. are also considered.

L 3. A team consisting of Instructional Materials Center personnel and teachers involved in the unit present an overview of facilities, equipment and resources to be used during assimilating activities. The following items are covered:
   a. Overview of the use of the library and library resources to be consulted during the unit, viz., bibliographic and subject related indexes and materials.
   b. Overview of the physical facilities to be used during the unit. Scheduling of the facilities, viz., conference rooms, small independent study rooms, lecture rooms and laboratories.
   c. Overview of the use and availability of instructional slides for student use during the unit.
   d. Overview of basic information needed for effective assimilating skills and desired effective and cognitive unit goals.

S 4. Question and answer sessions/discussion and feedback between students and members of the teaching team. Major purpose is to create understanding, identify problem areas and assist students needing additional help.

L. 5. Distinguished visiting professor (ecologist) lectures on "Man and His Environment" as an introduction to the unit. The 16mm ecology film, No Turning Back, is shown. Both speaker and film coupled with other initiatory activities are designed to motivate the student.

6. Based on previous counseling and testing information, students are grouped according to able, average and less able program tracts. Each group will have a different emphasis on content structure throughout the unit.
    a. Information on assigned topics for oral and written presentation are obtained as follows:
        (1) Able Students
            (a) Text level one; Weisz, P.B. The Science of Biology, McGraw-Hill Book Company, Inc.
            (b) Consult with IMC and resource materials for supplemental readings on file, viz., (Texts) Ecology, Mankind Evolving, Principles of Genetics, Political Economics, etc. (Periodicals and other printed materials) Scientific American reprints; "Human Evolution," American Transactions; Problems of Evolution, etc. (A.V. aids) maps, charts, filmstrips, slides, transparencies, etc.
        (2) Average Students
            (a) Text level two; Weisz, P.B., Elements of Biology, McGraw-Hill Book Co.
            (b) Consult IMC for supplemental readings and resource materials, viz., (texts) The Nature of Natural History, Man and the Living World, Ecology and Animal Geography, etc. (periodicals) Natural History Magazine, Science, Scientific American, etc. (other printed materials) Facts About Lead and the Atmosphere, Man and His Environment, etc. (AV aids) Maps, charts, filmstrips, slides, transparencies, etc.
        (3) Less Able Students
            (a) Text level three; BSCS Biology (Green Version)
            (b) Consult IMC for supplemental readings and resource materials, viz., (texts) Basic Ecology, Genetics is Easy, Study on Human Relations, How Men First Lived, and Audubon, Field and Stream, Science Digest, etc. (printed materials) Forest Conservation, Audubon, Nature Bulletins on Ecology, etc. (AV aids) Maps, charts, filmstrips, transparencies, etc.

B. Assimilating Activities:
1. Assign Student group projects to be given orally and written up as a unified research project.
    a. Able Students - Gather research data on amount of sulfur oxides, nitrous oxides, and particulate matter in the atmosphere.
    b. Average Students - Study local industrial complexes; location, industrial processes, pollution controls - installed, anticipated, etc. Assist in setting up and testing laboratory data.
    c. Less Able Students - Gather demographic data; population density records, hospital records of respiratory diseases, interview people in pollution attitudes survey, etc. Assist in setting up and testing laboratory data.

2. Assign independent study. Discuss IMC appropriate materials with students. For example, advanced students read printed material; Air Pollution Research and Clean Air; study filmstrips, Evolution and Environment, Effects of Environment. In addition, IMC has supplied the following charts and maps to be viewed; biological chemistry chart, conservation model, adaptations chart, etc.
3. Students attend seminar to outline the problems each group will face and discuss procedures. Teacher and IMC personnel offer assistance suggesting other resource materials that might be helpful. The teacher helps to guide the seminar.

4. Lecture; member of team shows filmstrip; Ploistocene Ecosystem. He contrasts primitive ecosystems with those in existence today. Question and answer session follows.

5. Field trip is made to local Science Center. Displays of fossils, models of geologic strata and epochs help students to perceive and contrast a number of ancient ecosystems with modern ones.

6. Field trip is made to a local industry with modern pollutant facilities installed.

7. Field trip is made to a local industry without modern pollutant facilities installed.

8. Student seminar. Students discuss changing environment and list all changes noted to date in notebooks. Teacher guides discussion and shows film, "Culture and the Evolution of Man."

9. Students return to IMC and corral for more self-directed study. Laboratory outline and other resources are available for appropriate learning level. For example, average student: Lab, outline procedures designed specifically for average student. Printed matter: Battle for Clear Air. Man and His Environment. The Rise of Man and How Plants and Animals Have Changed.

10. Laboratory demonstration: Team teacher and paraprofessional (technician) demonstrate the use of equipment to be used in the lab. Question and answer session follows.

11. Lab.: 'Respiratory physiology and atmospheric analysis." This laboratory introduces students to techniques involved in measuring atmospheric contaminants. Students have the opportunity to relate techniques and atmospheric analysis data directly to respiratory physiology.

12. Student seminar: lab procedures, data and conclusions are discussed. At the end of the discussion the 16mm film, House of Man, (Our Changing Environment) will be shown.

13. Lecture, "Man's Interaction with Biological Systems." Team teachers in biology and geology present intergrated lecture. Transparencies on "environmental influences," pollution and biogeochemical cycles are used to assist students with understanding subject matter content. A question and answer session follows. The 16mm film, The Silent Spring of Rachel Carson, helps to summarize the main points of the lecture.

14. Students return to corral for more independent study. IMC again provides resource materials and assists students by directing them to additional kinds of information. For example, less able students - Printed materials, Audubon Bulletins in Ecology, Man and His Environment, Audubon Nature Bulletins on Conservation. A kit, Man and His Environment; a filmstrip, Physical Environment, a programmed instructional aid, "Effects of Air Pollution" and a chart, "Biogeochemical Cycles."

15. Field trip is made to local hospital research clinic. Local medical researchers display preserved lung tissues from polluted and nonpolluted areas. Discussion of respiratory disease and pollution is conducted by researchers. Student interact with researchers and a question and answer session follows.

16. Field trip is made to a local agricultural research station. Researchers discuss pesticides and their role in agriculture.

17. Field trip is made to a local fish hatchery and fishery biologists discuss water pollution and its effect on the hatching of trout and stream ecosystem.

18. Student seminar: Students hear phonodiscs by Barry Commoner, Pollution Explosion and Paul Ehrlich, Universe Around Us. A discussion follows. Students are asked to identify the major environmental problems in the community. Further, students are asked to identify the major environmental threats to man. The 16mm film, Who Killed Lake Erie? is shown.

19. Lab. "Ecosystems - Plant and Animal." Students analyze and contrast a disturbed and undisturbed plant and animal community. A clearcut area is contrasted with an undisturbed area. Plant and animal succession are observed and analyzed and compared.

20. Students attend a seminar, students analyze, compare and discuss data collected on field trip. They develop graphs comparing temperature, humidity and light intensity to various growth forms and vegetative stratification found in both clearcut and uncut vegetative stands. A panel of experts consisting of a local forester, a plant ecologist and a geologist assist students in interpreting data.

21. Lecture; team teachers in English, biology and mathematics lecture on skills involved in technical report writing.

22. Students return to various groups to tabulate, discuss, and organize data gathered for research project.
    (a) Able students - organize, formalize information gathered on atmospheric pollutant research in the local area.
    (b) Average students - organize and formalize information gathered on industrial complexes, pollutant devices in effect, etc.
    (c) Less able students - organize and formalize demographic and hospital data as well as compile information from the pollution attitude questionnaire.

23. Students return to corral to write up their phase of the report. IMC provides each student with an outline from the book, The New Library Key (Cook, 1963). In addition both IMC and team

teachers offer individual assistance to students in writing the reports.

24. Student seminar. Students attend a seminar in various groups to discuss finalyzed data and appoint group chairman (spokesman) to act as their representative on the student panel.

25. A panel of field trip students summarizes the environmental and community data each group found. The findings are tabulated on the blackboard and discussed. Discrimination between students' group is avoided because of the team effort. All data is necessary for the final analysis and report. Hypotheses based on the data are listed on the board and carefully discussed. At this point, team teachers listen and guide the discussion, but they do not direct it. Student conclusions and actions will be based entirely on the data and will lead to the last part of the unit; what is to be done?

26. Lecture: team teacher from history and government department presents information on social, political and economic system. Transparencies, "The political-economic" series are used during the lecture. Following the question and answer session the 16mm film, The City and Its Problems is shown.

27. Student seminar: students listen to phono-disc, Time for Ideas - American History, social man, political thought and philosophy are discussed on the recording. Students discuss the ideas with the team teacher.

28. Guest lecturer: Judge from State Supreme Court discusses environmental law with students. The 16mm film, A Matter of Attitudes is shown and a question and answer session follows.

29. Students attend a seminar to discuss the problems, issues and apparent solutions. Each is carefully identified and listed on the blackboard. Copies are made up and dittos run for distribution to all students on campus. A community dialogue on environmental problems is suggested and the community is invited to join the students during an Environmental Crisis Day aimed at creating a better understanding of man and his environment - not only on a community level but on a national one as well.

30. Community leaders: lawyers, judges, doctors, etc. join in small group discussions and dialogue with students on environmental issues: the last 16mm film of the unit is entitled, Cities in Crisis: A Matter of Survival.

C. Correlation

1. Language Arts
   a. Reading, researching and writing for research reports.
   b. Use of new terminology and phrases
   c. Communication skills in speech, debate and discussions.

2. History
   a. A basic understanding of American history and government are essential for the understanding of environmental problems in this unit.

3. Mathematics
   a. Statistical and basic computation skills are necessary in tabulating and correlating lab data in this unit.

4. Economics
   a. A basic understanding of economic policies is essential for understanding causes of environmental problems discussed in the unit.

5. Library Sciences
   a. One must know how to use library resources to be successful in many aspects of the unit.

6. Sociology
   a. One needs a fundamental understanding of the social processes (culture) of man.
   b. One needs a basic understanding of current sociological theory related to urbanization, urban planning, food supply and overpopulation.

A TYPICAL SUMMER PROGRAM IN FIELD ECOLOGY 18

Gary Swant

Introduction

The integration of environmental concepts into all subject matter areas necessitates the increased involvement of students in relevant studies outside the classroom. At Deer Lodge an attempt to bridge the gap between the classroom and the student's total environment is underway through a summer program titled "Summer Institute in Field Ecology and Geology." This program is research-oriented for students interested in environmental studies.

The program is open to any student who has taken at least one year of science and who wants to learn more about his environment than can be offered by regular classroom instruction. For three weeks in June and July the students spend 10 to 12 hours a day, Montana through Friday, in concentrated environmental studies. During the last week of the institute they are involved for 24 hours a day for six days in environmental studies. What does the student get in return for these hours? He gets no grade, no credit, but he does gain knowledge about the most controversial and important topic of our time - environment.

There are no students nor instructors in this program. For four weeks 20 basic and 10 advanced students act as field research ecologists with the three instructors acting as co-workers. All studies are designed with an open-ended approach. There are no set answers. One series of field exercises teaches the student about the biomes of the Deer Lodge Valley, another teaches him about topography and the results of recent glaciation. Other studies, on water pollution and Douglas fir migration are research-oriented. The most important thing is that all of these studies bring out an awareness of the environment.

The final week of the institute for the basic students is in a six-day camp in the alpine region of the Flint Creek Mountain Range. At this study site the research is more concentrated, resulting in an introduction to alpine tundra.

The advanced group's studies emphasize research with at least one week spent on each investigation. Last summer's work dealt with a mouse habitat selection study, a geology study, and a food habitat study of the Deer Lodge Valley antelope which was continued through the school term.

Following is a typical summer schedule consisting of 18 related studies. The advanced schedule is more flexible and is designed by the students themselves.

Designing a Summer Ecology Program

A program should be designed to make maximum use of the local area. Thus, in the Deer Lodge program, we have a biome approach for two weeks, aquatic systems for one week, and a camp in the alpine ecosystem for one week. No two programs would be identical, but should be tailored to the region in which to be conducted.

The second most important consideration is that the program must be adequately staffed. When doing field work a ratio of one staff to 10 students is an ideal

ratio. In the Deer Lodge program there have been 30 students and three instructors complemented by one to three university student teachers.

About two weeks of preparation is necessary before the students arrive. This time is spent visiting study sites with all instructors, scheduling equipment to avoid conflicts, inservice training, and preparation of materials. After the students have begun their studies, there is little time available for preparation.

A week-long camp is highly recommended. This gives the student an incentive for working hard on the program and provides an opportunity for in-depth studies. Also, students live together and learn the benefits of cooperative effort in work and play.

Most of the equipment needed for a summer ecology program can be found in the average high school. The camping equipment can be secured by the students; however, the Deer Lodge project purchased tents for the program. The water and air pollution studies did require the purchase of additional equipment, but the price of this equipment is not unreasonable.

As a final thought in designing a program, resource personnel from county, state, federal and commercial enterprises is essential. Students have a chance to meet individuals who work in these areas. Also, these resource people can meet and work with high school students. Resource people must be familiar with your program and come to it with the understanding that they are going to help the students in field studies or give them background information. It is important that resource personnel do not become lecturers.

The cost of a summer ecology program will vary with each program. However, most of the funds in the Deer Lodge program pay for salaries of the three instructors for a month of teaching and two weeks of preparation. The six-day camp in the alpine eco-system is financed by students. The main cost is for food. The other major expense is mileage. In the Deer Lodge project a total of 7,000 miles is logged in a typical summer. After three years of purchasing equipment with federal funds (ESEA Title III), the Deer Lodge project cost the local school district $5,000 per summer. This local funding includes staff salaries, a cook's salary for the camp, insurance, chaperon, mileage and repair and purchase of equipment.

What are the results of such a program? The Deer Lodge staff feels that (1) there is an awareness of the environment and of man's responsibility to it, (2) the realization by the student that a person can work for the sake of gaining knowledge without the reward of grades, and (3) that teenagers can make significant contributions to scientific knowledge.

All of the evaluations collected indicate that the Deer Lodge project is a successful environmental studies program. The following quote from one of the students is highly interesting: "I used to look at a mountain and see a mountain, now I see an interrelationship of plants and animals. But more important, I see the factors that will keep them there."

Certainly this girl has become what all of us in environmental education are trying to achieve with our students--an environmentally conscious citizen.

Summer Institute

Basic Group - Teams A & B (10/Team)

Staff: Gary Swant - Director
Ray Larsen
Al Finley

June 22, Mon.	June 23, Tues.	June 24, Wed.	June, 25, Thurs.	June 26, Fri.
All Keying of Plants Cliff Mountain Geology of Cliffs	Aquatic Keying Concepts of Ecology Dr. Barry	Bird Walk Morning Insect Keying Afternoon	Soils Fields	Range Management A B Warm Springs Creek
June 29, Mon.	June 30, Tues.	July 1, Wed.	July 2, Thurs.	July 3, Fri.
Grassland A	Douglas Fir A	Lodge Pole A	Spruce Fir A	Warm Springs A Creek
Pond Study B	Pond Study B	Clark Fork B	Glaciation B	Range Management B
July 6, Mon.	July 7, Tues.	July 8, Wed.	July 9, Thurs.	July 10, Fri.
Pond Study A	Pond Study A	Clark Fork A	Glaciation A	All
Grassland B	Douglas Fir B	Lodge Pole B	Spruce Fir B	Forest Service
		CAMP		
July 13, Mon.	July 14, Tues.	July 15, Wed.	July 16, Thurs.	July 17, Fri.
Geology Elbow Lake Fire Burn	SubAlpine Kingdom Survey	Alpine Meadow Survey	North & South Slope Abiotic Study Race Track Peak	Evaluation and Clean Up

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DEVELOPMENT OF OUTDOOR STUDY SITES 19

Charles Larson

Introduction

A classroom is not limited to a physical structure contained within a building. It is a place where students learn. If this philosophy is adopted into an environmental education program, the need for identifying and developing outdoor study sites (outdoor classrooms) becomes mandatory. The learning experiences a teacher provides for a student should be related to, or be a part of, the environment a student lives in every day. Therefore, a program for the development and use of outdoor study sites should be undertaken by all school districts interested in environmental education.

The following procedure is based on the acquisition and development of outdoor study sites at Hamilton, Montana, by its Environmental Education Committee. It is not the intent to describe what will be contained in the study site, since the contents of the site would depend on the locality of the community and its ecology and the desires and needs of the program being developed.

I. Inventory of All Possible Sites

The first step is to make an inventory of all possible sites within a reasonable distance from the schools. Some of the natural ecosystems to look for are timber or woodland, marsh and swamp land, grassland-prairie, rivers, lakes, ponds and alpine areas. These sites can be divided into two categories: those requiring transporation from the school and those within walking distance. Each of these categories can be divided into natural sites and those needing development and improvement.

The first and most obvious location is school district lands, especially those on-campus areas surrounding the schools. This type of land is often overlooked as a possible area for development into outdoor study sites. With a little imaginative thinking even the smallest piece of ground can be developed and utilized effectively.

The County Superintendent of Schools can be contacted to determine the possibility of using state school lands for study sites. If the schools are within the city limits another possibility for land is city-owned property. The prospect of developing a visually appealing area within the city quite often will appeal to the citizens of the community.

County, state and federal lands should be included in an inventory of possible land. State and federal agencies, if contacted, could be helpful in identifying specific locations that may be of value for learning experiences. And the use of private land should be explored, because many people would be pleased to allow students to use their land for study purposes. Do not overlook areas within the city or town, such as yards, garden plots and vacant lots.

II. Determine the most easily accessible and useful land.

After taking an inventory, determine which sites best suit the needs of the

outdoor program. Some of the factors that should be considered are:

1. How many students will the site serve?
2. How far is the site from the school and will the teachers utilize the area?
3. How much work is required for development?
4. How much money will be required for development?
5. What kind of study site can be developed in terms of existing ecology?

III. Acquisition and use agreement

Secure administrative approval from the school board for the project as their help and backing is necessary for this type of project.

After selecting the area most suitable for outdoor study sites, contact those involved to work out use of the land. The right to use the land may be secured in several ways:

1. Direct purchase - obviously this would have to be accomplished through the school board.
2. Donation to the school district - be sure the land is donated for this purpose only.
3. Lease agreement - make the contract legal and binding for the protection of both parties.
4. Non-binding written or verbal agreement - this is the least desirable but might be the only alternative.

Check into the problems of insurance, liability and other responsibilities before finalizing any agreement. Anticipate the problems beforehand.

IV. Community support and involvement

Much of the work described in the first three steps could be made easier if people know from the beginning what the project is to entail. In some cases people from the community may help secure the study sites as well as offer suggestions for possible sites.

To obtain community support first identify all available city, county, state and federal agencies that may be of help. Also, identify all interested community organizations and interested citizens who might work on such a project.

Then personnally contact these people and arrange a meeting to explain the program. Include in the presentation:

1. The need for environmental education in the school curriculum.
2. The need for outdoor study sites as part of this curriculum.
3. The need for community assistance in the development and operation of the program.

Open the meeting for discussion to allow feedback from the people involved. After any discussion it may be worth formulating some guidelines or a course of action that the group would agree upon. And last, but most important, secure a commitment from as many people as possible involving all stages of site development.

If the community responds favorably it may be worthwhile to develop a resource guide that would identify interested people and list what they could contribute to the environmental program or to any other aspect of the school program. This guide could be good public relations and be helpful to students and teachers.

V. Student Participation

Student involvement in the development of outdoor study sites is highly desirable in all phases of planning and development. Remember the sites are for student use and their ideas and suggestions can be invaluable.

VI. Financing for development and operation

Most of the problems will center around financing. Although there is not easy solution, several possibilities can be considered if the local school district is not able to fund the project.

1. With strong community support for the project many things may be donated from businesses--such as labor and use of equipment and materials.
2. Some state and federal agencies may have money available for outdoor study sites, outdoor recreation, conservation education, etc.
3. Students themselves may donate time to the project. Development of the site may be a better learning experience than using the completed site.
4. Donations of money, time and materials may come from civic groups, fraternal organizations and private individuals.

When setting up finances for the project or showing expenditures, be sure the figures are as accurate as possible and all money is accounted for in the budget.

Summary

The project depends on the success of the following steps:

1. Talk to the teachers and inform them of the project and attempt to obtain their support.
2. Get the support of the administration and school board. Approval of a project does not necessarily mean support.
3. Involve the students as much as possible.
4. Involve the public. In some communities this may be the key to the entire project.
5. Be honest in the information presented about the project.
6. Keep the public, teachers, students and administration informed of progress. Carry on a public relations program by using newspaper articles, radio, TV and by going before interested groups to explain the project.

AN ENVIRONMENTAL ACTION PROGRAM

Ralph Allen

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Introduction

"If I cannot do great things, I can do small things in a great way." (Ecology Begins at Home, p.1)

Jerome Bruner, in a very important educational book of the 1960's entitled, The Process of Education said, "Something new is stirring in the land." Certainly a part of it is a wholesome concern for the environment in which we live. This concern is heard in coffee shops, legislative circles, industrial offices and classrooms from coast to coast. Newspapers, magazines and television have responded to the issue with articles and programs geared to developing environmental concern and awareness. The complexities of the issue are presented in publications such as Ecology, Economics, Environment, Spring 1971, published by the School of Forestry at the University of Montana. In one of the articles of this booklet, Leslie Pengelly stressed the serious condition of environmental degradation on a nation-wide scale. He said: "We must grow up and accept our responsibilities as a nation. The longer we evade these responsibilities the greater will be the dilemma. Millions of new lives are being added to our already over-crowded spaceship: a new soul is born every time your heart beats. Any future debate about the quality of life will be academic under such conditions. Our survival as a species is already in question, and yet we fritter away valuable time debating semantics. Historians tell us that while Russian peasants were storming the palace walls 53 years ago, the aristocrats inside were being entertained by a string quartet playing Rimshy-Korsakim's latest composition and were debating which member of the ballet company had performed best. And so it is in America."

Americans were concerned, but they are not yet "storming the palace walls." In our democratic way of life the kinds of frustrations which have arisen from the ferment of environmental degradation can best be released in positive action toward righting past environmental wrongs. The American people have risen in the past at times of national emergency to unite individual concern with community action toward positive and reasonable solutions. It is inevitable in a democracy that educational institutions are irrevocably tied to these kinds of national movements. The very backbone of the democratic process demands that the majority of citizens be actively involved in seeking reasonable solutions to national problems. It is the responsibility of educational institutions to prepare the young for decision-making. Bruner said, "Whatever we teach must stand the test of being able to serve us in the future or be discarded into the annuls of second rate learning."

School children today reflect the national tension, unease and frustration which adults have over environmental degradation. There are many reasons why educators must respond to this concern and help students bring it to the level of active participation and commitment for improved conditions. One reason for active student involvement has already been alluded to in this paper - it is simply that concern leads to frustration unless channeled into positive action. Closely tied to this concept is the recent trend of educators to take the children from the classroom into the world instead of taking the world into the classroom.

When students begin to work outside the schoolroom, chances are that not only will their education become more relevant, but community involvement will begin to pick up. Environmental education may well be the issue which can aid school support by integrating community action with classroom activities.

Another aspect of environmental education is that by its very nature it is an integrated topic involving virtually all areas of human activity including science, social sciences, mathematics (ecology is mathematics oriented), language arts and the other humanities. Educators have been searching for the theme which will integrate these difficulties into a meaningful aspect of full human endeavor; perhaps the national environmental crisis will do this.

Finally, environmental education, geared to action, with all its ramifications and unknowns, provides a problem-solving situation in which students can become actively involved. As teachers view the "knowledge explosion" they continually stress the need to aid students in developing an "intellectual style" which will prepare us all for problem-solving necessary in an increasingly complex world. With over half of the jobs of the 1980's yet to be created, the ability for each person to solve complex problems through critical thinking and appropriate action becomes of utmost importance. Bruner emphasizes this and says we can teach any concept at any age level in some intellectually honest form.

Environmental programs consist of two levels - one of awareness to bring about concern for environmental degradation and another of action which must follow concern based upon the assumption that constructive change, action and commitment can best relieve the frustrated feeling of unease brought about by concern. An environmental program geared to action lends itself to the following concepts.

1. Getting children out of the traditional school setting.
2. Getting students involved with other segments of the community
3. Integradation of scholastic disciplines
4. The active seeking of reasonable solutions to serious and relevant problems through inquiry and social involvement.

One sound way to update an educational program in any school at all levels of instruction is to incorporate an environmental program geared to action.

On the following pages are a few of the kinds of activities a school might consider useful in developing an environmental program. In no way is the list complete or geared to an individual school or teaching situation. All items must be adapted to local conditions, timed to individual student interest and to the specific environmental problem at hand. Working toward quality environment is costly in terms of time, energy and economic sacrifice. Sacrifices, particularly economic, must be made by the American people. Not all are willing to make these sacrifices. Courage and perseverance are necessary qualities for those who become committed to bettering rapidly decaying environment.

It is not the intent of this cell to provide a teacher with step-by-step directions. It is, rather, to suggest a few ideas which have been used by teachers, students and other citizens in other parts of the nation in hope that some of these will be "seed ideas" which will germinate, grow and mature to their full potential in a school and community.

WAYS TO HELP

Give presents that do not pollute or drain appreciably from diminishing natural resources. Conservation magazines, environmental books and memberships to ecological-action groups make excellent gifts. Handcrafted gifts do not pollute.

Provide garbage receptacles on the school grounds, in residential areas, parks and downtown. Encourage the use of these receptacles by all students, teachers and parents.

Assist in the development of an outdoor study area that can be used by all students and teachers for nature study on the school grounds. Corners of parking lots should be available for such resource use; vacant lots near the school grounds, and parts of athletic fields are other possible sources for outdoor study area development. If your district is building a new school, students and teachers can work to insure that adequate outdoor study facilities be provided. Often woodlots, marshes and meadows already existing are destroyed by "developers" through thoughtlessness and insensitivity to nature when building a school.

Can you and your students help make your school building and grounds more attractive? How about some planters for flowers and vines in the school entrance, halls and classrooms? Are classrooms painted and decorated so that they are pleasant places to be? What kind of landscaping, trees and shrub planting, etc. would make your school look beautiful, rather than like just another school building? Perhaps a class project could make this an inexpensive and worthwhile undertaking.

How many different ways can you and your students use a piece of paper before discarding it? Never throw away paper until both sides are completely used. Have students discuss the importance of picking up litter instead of taking it for granted that the janitor will do it. This concept can be extended to picking up at parksites, athletic events, civic affairs and wherever we go.

Have your classroom be a 'living classroom' with a rich variety of plants and animals for students to observe, study and learn to love and appreciate. Student responsibility toward the caring of these is difficult, and requires much understanding and patience, but if successful, is most rewarding.

Students can sponsor environmental speakers for school and community events.

They can become involved in environmental issues, expecially when the state legislature meets. Keep abreast of legislative bills dealing with environmental problems and discuss the merits of demerits of each bill. Allow and encourage students to write legislators to express feelings toward or against pertinent issues. (Last year a fifth grade class from Hellgate grade school in Missoula went to Helena to lobby for the protection of the mountain lion as a game species).

Have students keep a posted list of public officials and the environmental voting record of each in public places around the community. Keep these records accurate, up-to-date and discuss them in class.

Perhaps it is worthwhile for your class to sponsor a community drive to enlist cooperation of all community members in banning or not purchasing materials in non-returnable or non-recyclable containers.

Construct a litter tree. Have children bring litter which they collect on the way to school and hang it on a dead tree in the corner of the room. Call it the "Litter Tree." Let children decide how long to keep it. Are we enjoying it? Is it pretty? What should we do with it? Can we make a better environment? Let's plant a real tree instead of a litter tree.

A class project to create a mini-park in town can be exciting and a valuable learning experience. Townspeople can be included in this project.

Mechanised outdoor recreation vehicles such as motor boat, snowmobiles, tote-goats, trail bikes and jeeps all contribute to environmental degradation in the form of noise, exhaust, material consumption and ecological impact upon the living things in the outdoors. Consider for classroom discussion and debate the advantages of snowshoeing, canoeing, hiking, back-packing and bicycling over the previous list.

Stories, poems and art about environmental issues of appreciation are only limited by the imagination and incentive of you and your class.

Your class could prepare a slide show or an 8mm film concerning local environmental enhancement or degradation and present it to the PTA and other community organizations.

Writing of environmental editorials by your students and yourself provides an excellent opportunity for positive learning. Good editorials are difficult to write, require clear thinking and are motivating agents.

If you have a company polluting in your neighborhood invite the officials from the company to your classroom. Discuss the problems involved and pathways to reasonable solutions. Remember too, that a great portion of our industrial representatives are as concerned about pollution as you and I.

Public health authorities, doctors and environmental researchers can aid your class in finding information and implementing change for a better quality environment.

Discuss the environmental disadvantages of buying alligator purses or shoes, leopard coats or any product made from skins or feathers of endangered wildlife species. Your class can go out into the community to urge cooperation in banning these products from the markets. If we refuse to buy these products the demand will cease.

Find out the adequacies of your local sewage treatment plant. If it is less than tertiary you probably have a problem. Your students, local health officials and community members can immediately go to work to alleviate the problem. Solving complex problems of this nature challenges the thinking and democratic processes of students much better than the so-called "prescribed curriculum" usually does.

In an agricultural community consider the value of spending class time in trying to solve the problems of pesticides, herbicides and artificial fertilizers of modern agricultural practices. There is a wealth of information available on the ecological hazards of these practices and possible alternative solutions. Work with the agricultural industry in seeking solutions, if possible. The complexities of this problem will keep your class busy and learning in a relevant manner for a long time.

Work to get farmers or landowners to leave some unmowed, unburned fence rows, hedgerows and brush piles for wildlife habitat. A fenced off vacant corner will enhance wildlife habitat. Fencing river banks prevents soil erosion and provides habitat for fish. Livestock can be allowed access to water in limited "watering regions." Support legislation which will aid the landowner in providing these kinds of ecologically sound practices.

Investigation of your local community sign ordinances might prove worthwhile. Few objects detract as much from the immediate environment as the indiscriminate projection of billboards and signs upon the public eye. Pictures of these eyesores, guest speakers and community discussion sessions can help to focus the students' perception of the problem, and will eventually aid in the solution.

The national forests are another important aspect of environmental concern in Montana. Recent debate at the national level involving clear-cutting of the forests has focused upon a particular national forest in Montana. The whole concept of multiple use is undergoing intensive investigation. Local conservation groups like the Sierra Club, garden clubs, Wilderness Society, National Wildlife Federations, etc. will be happy to provide speakers. The Forest Service also will aid you in seeking information on forest-related problems. Representatives of various points of view can be helpful in allowing students to draw their own conclusions.

Section II

The Conservation Education Association has produced Guidelines for Citizen Action on Environmental Problems. Permission has been obtained to print some of these in our action unit. Although they are not specifically written for the classroom, slight modification would make these items pertinent to the public school situation. They are:

AIR POLLUTION:

1. Do not burn leaves or trash. Why not start your own compost pile to return the nutrients in leaves and other wastes to the soil?

2. Do not let your automoble idle unless necessary. The automobile is the single greatest source of air pollution; conscious efforts should be make to reduce its contribution.

3. Walk, bidycle or use rapid transit rather than your car, whenever possible. If you must drive, form driving pools.

4. When buying a new car, ask for detailed information about pollution control equipment. Compare the cars you are considering, and buy that one which has the best abatement device. In general, smaller engines cause less pollution than larger ones.

5. Check to see if your town has an air pollution control ordinance. If it does not, or if it is ineffective, copies of model ordinances can be obtained from the National Air Pollution Control Administration.

6. Keep your car well tuned. Air pollution control devices need constant upkeep. A tuned car emits less pollutants.

7. Make an oral or written statement at hearings on air pollution and insist on enforcement of air pollution laws. Report offenders.

8. Stop smoking. The average New Yorker takes into his lungs the equivalent in toxic materials of 38 cigarettes a day. Don't add to the problem... for your own body and for your environment.

PESTICIDES:

1. Chemical poisons should not be used for pest control except when absolutely necessary for health or economic reasons. Chemical poisons should never be used for nuisance pests like midges or mosquitoes. Never dispose of pesticides by emptying into a water supply. Call local health offices for disposal methods.

2. Consider alternatives before using chemical poisons.

   If you must use a chemical poison, follow these guidelines:

   a. Use only recommended dosages

   b. Use at the proper time of year

The following pesticides have been recommended by several authorities as being "acceptable" for careful and restricted use. While they may be the pesticides of choice, it should be clear that they are no substitute for the polluting pest control measures:

Pyrethrum--A natural insecticide that does not persist and is essentially non-toxic to warm-blooded animals. Fish are more susceptible. There are, however, many cases of humans developing a strong allergy. Often combined with the synergist, piperonyl butoxide. (Allethrin is a synthetic analogue.)

Rotenone--An insecticide which is naturally produced by some plants. Low toxicity and apparently no carcinogenicity. Poisonous to pigs and fish.

Ryania and sabadilla--Also naturally devided insecticides. Apparently "safe."

Nicotine sulfate--Highly toxic but not persistent.

Carbaryl (Sevin, 1-naphthyl N-methylcarbamate)--Relatively non-persistent and said to be harmless to wildlife. Widely used. Recent evidence indicates that Sevin is teratogenic (fetus-deforming).

Methoxychlor (2,2-bis-) p-methoxyphenyl)-1, 1, 1- trichloroethane)--Significantly less toxic than its sister chlorinated hydrocarbons. Persistent but apparently can be metabolized by living organisms. Lethal to fish but apparently doesn't cause serious damage if properly used.

Malathion (O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate)--Relatively non-toxic for an organic phosphate. Severe kills of birds and fish have resulted from indiscriminate use. Especially rough on bees.

Diazinon--A nonselective, reasonable short-lived phosphate. Toxic to birds and fish.

Abate--A larvicide that is used for mosquito control but that doesn't kill the adults. Generally considered safe around small mammals, birds and even young rainbow trout, but it is toxic to shrimp and may kill other crustaceans.

Baytex--An organic phosphate that disappears fast. However, a concentrated dose kills birds almost on contact. Will kill bees and shorebirds at the doses recommended for mosquito control.

Dessicants--These kill insects by drying them out on contact, penetrating their waxy exoskeletons. Non-toxic to humans and pets. They include Dri-Die (silica-gel), Drione (with pyrethrum) and Perma-Guard (diatomaceous earth).

Milky spore disease--A bacterial insecticide specific for Japanese beetle grubs.

"Bacillus thuringiensis"--A bacterial insecticide specific for a variety of species of moths and certain other Lepidoptera.

Bordeaux mixture--A fungicide and insecticide consisting of a mixture of copper sulfate-calcium bydroxide. Avoid mixtures fortified with lead for calcium arsenate.

Warfarin--A rodenticide that, on repeated exposure, acts as an anticoagulant. Will kill rats and mice. Presumably a child which ate it all at once would only get sick.

Do not under any circumstances use the following:
(CHECK LABELS CAREFULLY)

Dieldrin	DDT, DDD	Arsenic
Endrin	Chlordane	BHC
Aldrin	Lindane	2,4,5-T
Toxaphene	Mercury	Kethane
Heptachlor	Lead	

1. Recommended pesticides are brands including ROTENONE, SEVIN, MALTHION and PYRETHRUM.

2. Avoid direct contact with the pesticides used, including the mists. Some, such as PARATHION, can be absorbed through the skin, directly, and cause serious damage.

3. Apply carefully and only where necessary. Never near food or water.

4. Planting a mixture of trees, shrubs or garden plants instead of a mono-culture, reduces chances of an insect outbreak.

5. Removal of dead or diseased plants reduces the sources of pest populations.

6. Remove weeds in lawns by hand rather than by applying herbicides.

7. Accept produce with blemishes caused by insects or plant diseases. Farmers are often forced to use chemical sprays merely to save the appearance of produce.

8. Block the use of herbicides on roadside vegetation. Encourage the development of hedgerows with a pleasant visual effect. Varied roadside vegetation serves as a valuable source of insect predators.

HERBICIDES:

1. The same general rules for pesticides apply to herbicides.

2. Weedkillers are often placed in three categories:

a) Pre-emergent weedkillers: those which are applied before weed seeds germinate - the only class of herbicides safe for use near vegetable lots, fruit trees or flower plots and lawns.

b)

DCPA	Diphenamid
Trifluralin	EPTC
Ambien	Siduron

c) Post-emergent weedkillers: Those which are applied after weed seeds germinate - effective on growing broad-leaf plants. Consumer Reports advises that tests have indicated that several esters of 2,4-D and 2,4,5-T have potentially dangerous fetus deforming effects.

d) Non-selective weedkillers: those which kill all growing vegetation. Amitrole is cancer inducing and also has fetus deforming effects.

Amitrole
AMS
Dalapon

3. Consumer Reports advises gardeners that none of the weedkillers should be used around children or pregnant women. Removal of weeds in gardens and lawns by hand is much safer than applying a herbicide.

4. Block the use of _____

PESTICIDE AND HERBICIDE PRODUCTS TO WATCH OUT FOR

Avoid lawn products that combine herbicides with fertilizers:

Scott's Turf Builder plus 2 (2,4-D) and Halt's Plus

Avoid products that contain extremely toxic or persistent chemicals:

Shell, Raid, and Black Leaf Ant and Roach Killers contain dieldrin.
Real-Kill Bug Killer in a "new bug gun" that "makes bug killing fun!" contains dieldrin.
Arsenic is contained in crab grass killers by Black Leaf, Everready and Breck.
Scott's Haze Rose Care (powder) contains 5% DDT.
Antrol Multi-purpose Rose Spray and Black Flag Wasp & Hornet Killer contain lindane.
Vigoro Fungicide for Turf and Dichondra contains methylmercury dicyanamide.

Any product bearing a DANGER, POISON or WARNING on the label is too toxic for home use.

Be wary of products that promise long-lasting action:

Shell No-Pest Strips contain Vapona (DDVP) imbedded in wax. As the wax evaporates, the Vapona is released. In hot, humid weather the

release can be rapid enough to deliver more than the designed dose. You and your food are exposed over long periods of time to the same concentration of this nerve gas that the bugs are. It kills them.

Watch out for pesticides in the following products:

Shelf paper impregnated with chlordane and lindane. Because tolerances for these pesticides in food have not been set, USDA and FDA have had trouble banning the treated paper.
Dry cleaning fluids with some types of mothproofing.
Swimming pool chemicals.
Furnace filters.
Paints.

Stay away from applicators that pose unacceptable risks to the user or his environment:

Burgess Vibrocrafters' Insect Fogger (120 volts, 8 amps for $20) says on the box: "Fogged areas may be occupied immediately, but the insect-killing effects remain for hours." Their Special Insect Fog Insecticide contains 1% malathion. Good luck!
The Bernz-o-matic Super Jet Fogger ($35) is propane powered and is similarly advertised. The packaging encourages you to use it for picnics, fishing, camping and barbecues. Don't breathe deeply.

WATER CONSERVATION:

The following points are things individuals can do to help:

1. Have your plumber adjust your toilet tank to use less water. By lowering the water level this will provide great savings in your water bill and the toilet will operate as effectively.

2. Do not use colored tissue, colored paper or colored napkins. Dyes released in the manufacturer's effluent pollute streams visually and biologically.

3. Turn off or request that officials turn off all drinking fountains or bubblers which flow continually in hallways, public places, etc.

4. Let your lawn or yard go "natural." Instead of massive watering or irrigation efforts, plant vegetation which can flourish under normal rainfall conditions with a variety of species.

5. Switch light bulbs not used for reading to lower wattage bulbs. Be conscious that lower electrical power consumption reduces home or office operating costs and reduces thermal water pollution loads at the electrical generating plant.

6. If your bathtub has a shower, put a plug in position to measure how much water is used during your shower. After comparing the volume used for a shower versus a bath, use whichever procedure saves more water.

7. Make arrangements with the local sewage treatment plant and/or water purification plant to provide tours for organizations to which you belong, i.e., church groups, school classes, social groups, business groups, service clubs, a parent-teachers organization or a neighborhood circle of friends.

8. Determine how much leakage takes place in your community's water supply system, and what steps need to be taken to reduce that loss.

9. Use detergents, toothpaste, shampoos and other household commodities which have the least detrimental effect on the water environment where they will eventually end up. Request information on effects of content by writing to company presidents and sending copies of letters to political representatives.

10. Discourage the practice of street washing, unless the advantages clearly outweigh the disadvantages in your city. Too often this practice is left over from the days of manure in the streets.

11. Take personal steps to see that oil and other products do not leak out of your car onto the streets and driveways. Request that your city officials use only enough salt to safely handle traffic -- excess salt is damaging to vegetation.

SOLID WASTES:

Solid wastes cause either land pollution or, if burned, air pollution. Every effort should be made to cut down on the volume of such wastes. The average American generates about five pounds of solid wastes per day. The general answer is to minimize wastes by curtailing excessive packaging, and to recycle wastes.

1. Use returnable bottles, not throw-aways or cans.

2. Don't purchase liquids sold in milk-white plastic containers. This material is polyvinyl chloride.. When burned, polyvinyl chloride produces a very strong hydrochloride acid mist which can destroy nearby vegetation as well as the inside of an incinerator.

3. Don't buy products with merely decorative unnecessary packaging. Tooth paste and shampoo containers, for example, don't need outside paper boxes.

4. Develop compost poles that cut down on the volume of organic matter you throw away.

5. Take your own basket shopping to cut down on the use of paper bags.

6. Reuse paper bags, boxes, plastic bags, envelopes and other containers.

7. Carry a litter bag with you and collect the litter your fellow citizens cause. It costs the State of Michigan 32¢ for every piece of litter its crews have to pick up.

8. Conduct a paper and metal can drive in your community to encourage recycling.

9. Use handkerchiefs, cloth napkins and towels, instead of paper.

NOISE:

1. Support local noise pollution ordinances, and get them strengthened.

2. Be sure your own muffler, radios, air conditioners, TV's, etc., are not part of the noise problem.

3. Be sure that motorcycles, model airplanes, construction equipment, boats, etc., have adequate noise control devices.

4. Support efforts to ban sonic booms. Join the citizens League against Sonic Booms.

5. Make a tape recording of your local environment and play it back at City Council meetings to support demands for noise control.

6. Demand that airports be developed and zoned away from population centers.

7. Provide noise-free bubbles or cubicles in city parks for everyday use.

8. Encourage the Federal Aviation Agency to set noise abatement standards for airlines.

VISUAL BLIGHT:

1. Check to see that your community has a strong sign ordinance.

2. Keep your own environment clean and attractive. Do Not Litter.

3. Seek landscaping ordinances that require shopping centers, housing projects, and schools to include landscaping and open space in their development.

4. Encourage the use of easements and buffer strips along highways and roads.

5. Encourage groups to plant flowers and other vegetation in your community.

POPULATION:

Too many people placing a great demand on our resources cause problems.

1. Support a government-sponsored campaign in the media to encourage voluntary population control and family-planning programs.

2. Join a zero-population club or start one in your community--they stress the two-child family.

3. Encourage adoption of additional children for those who desire large families.

Section III

We include these excerpts from Ecology Begins at Home by Ecology Action at San Fernando College.

An Explanation

Each of us is responsible for preserving our environment. This begins at home and at school with some deep thinking about our own lifestyle. When you buy, do you consider whether the product is a wise use of our diminishing resources and where it will go when you have finished with it? Have you been

regarding your trash can as magical; just toss anything away and it disappears? Does 'population explosion' mean someone else, somewhere else? The key to effective ecology action is in thinking about these questions before you buy, before you use, before you throw away. Always remember that you are at once part of the interconnecting system of life and a potential means of destroying life. We are all in a position of incredible responsibility as we face the grim challenge of the present to afford the opportunity for a future.

Here are some suggestions designed to indicate a new direction of lifestyle, a direction toward living compatibly with nature and reducing our impact on the environment. We have categorized these ideas accoring to rooms and areas of the home for your convenience.

The Kitchen

The kitchen is often the center of the home. It is also often a major site of over-consumption and waste. Electrical and natural gas energy can be needlessly wasted here if you fail to turn appliances off when they are not in use. Limit the use of electric appliances as much as possible during peak time, between five and seven in the evening. During these hours an overload is put on our current electrical power plants and encourages the building of new plants for our environment to contend with.

In the kitchen and around the whole house, consider what is essential and what is a luxury. Electric knives, can-openers, frypans, toothbrushes, blankets, etc. are convenient but increase consumption of electricity and your electric bill.

Water is one of our most valuable and most abused resources. Stop and think about how you can take real steps to conserve it. Do not leave it running when you are not using it. A soap powder is generally less pollutant than a detergent. Amway LOC and Shaklee Basic H are high powered, all purpose cleaners which are also biodegradable. This means that they can be broken down in the biosphere and returned to the ecosystem, rather than persisting in a harmful form. The two products are effective in cleaning tile, ranges, refrigerators, plumbing fixtures, dishes and in removing wax from floors.

When you shop for food, take into consideration what you can bake, make and grow yourself. Read labels carefully and learn which ingredients are preservatives and other additives. Consult the library to find out just exactly what you will be eating today...Consider too, the containers in which products come. Can they be recycled? If we continue to waste at our present rate, we may bury ourselves in our own refuse. The per capita waste in this country is five pounds per day. This cannot and need not go on. Ecology groups such as ours have been exploring the channels for reusing our natural resources. We ask you to help implement plans for recycling.

Products which are not recycled at all by manufacturers at this time include plastics and wax-coated containers. Purchase these sparingly and reuse them at home. Cottage cheese containers and similar items are excellent for freezing and storing. Tin cans are actually steel cans coated with tin. This mixture makes them impractical for industrial reuse. Pencil holders and penny banks can be made from them. Talk to your local nursery school teachers about using tin cans for craft projects. Common paper products such as paper cups, napkins and towels are not recyclable at this time. Remember that paper equals trees and use only cloth napkins and towels and avoid paper dishes of any kind. Pack your child's lunch in a lunch box and carry your own reusable sacks to the store or at least reuse the bags provided by the store. In short, think about reusing whatever you can.

Aluminum cans are not biodegradable, that is they will not break down in the environment. Any aluminum soft drink can which is thoughtlessly thrown from a car window will be around for about 2,000 years. It is your responsibility to see that any aluminum cans or other aluminum containers which you buy can be recycled.

Food is very directly biodegradable and recyclable. Compost your garbage in the garden and feed scraps to your pets or the wild birds around your home.

In addition to being a center of activity for you and your family, your kitchen is often the one room in your house most subject to insect invasion. However, the kitchen is no place for residual insecticides. They penetrate food and the human body and accumulate in fatty tissue. Shell No Pest Strips attack the nervous system. The basic strategy for control of household pests is to eliminate the conditions under which they thrive. Roaches and silverfish feed on food crumbs and live in dark places. If you keep your living spaces light and clean, they will be unattractive to such pests. Dridie, a non-residual powder may be used safely to destroy stubborn roaches and silverfish. Houseflies are bred in animal excrement. Bury or water-blast this material in your yard. Screen on doors and windows will help keep flies out but if they do get in, kill them with a fly swatter. With ants, the elimination of such conditions as food left out will help greatly. Grant's Ant Stakes are non-residual if a poison must be used, but use any poison only with extreme care.

As you can see from these suggestions, there is much to be done in the kitchen for the sake of ecology. As you put each of these suggestions into practice, think of new ways to lessen your impact on the environment. Each of the ideas presented here was thought of by someone, someone like you.

The Laundry Room

Like the kitchen, the laundry room is a site for either the conservation or pollution of water. The basic rule here is to use soap powders such as Lift, Biosafe, Besline, White King Soap, Citrus or Ivory Snow, instead of detergent. The factor which makes detergents harmful is the presence of phosphates in large concentrations. When broken down in water, phosphates nourish algae until this type of organism accumulates, dies, and decomposes in bodies of water. They cut off the oxygen and light supply to the rest of the waterlife and the result is such tragedies as dead Lake Erie. You can help to avert future tragedy by being aware of the phosphate counts of products on the market. Here is a list of popular detergents and their respective phosphate counts. Data source for second printing of Ecology Begins at Home: Federal Water Quality Administration.

Axion (Colgate Palmolive) 63.2%
Biz (Proctor & Gamble) 73.9%
Bio-Ad (Colgate) 35.5%
Salvo (Pro & Gam) 30.7%
Oxydol (Proc and Gam) 30.7%
Tide (Proc & Gam) 49.8%
Bold (Pro & Gam) 30.2%
Ajax Laundry (Colgate) 44.6%
Punch (Colgate) 44.2%
Drive (Lever) 47.4%
Dreft (Proc & Gam) 44.9%
Amway SA8 34.8%
Gain (Proc & Gam) 39.5%
Duz (Proc & Gam) 38.3%
Bonus (Proc & Gam) 37.5%
Breeze (Lever) 37.2%
Cheer (Proc & Gam) 36.3%
Fab (Colgate) 34.8%
Cold Power (Colgate) 19.9%
Cold Water All (Lever) 45.4%
Wisk (Lever) 7.6%
Diaper Pure (Boyle) 5%
Trend (Purex) 1.4%
Shaklee Basic L. Less than 1%

As you can see, there is a wide variation in phosphate counts among washday products. Those having a lower count are, of course better than those with a high count. Soaps, which contain no phosphates at all, are the best answer. To get maximum cleaning power from soap, first strip detergent residue from clothes by washing them in hot water and four tablespoons of Arm and Hammer washing soda. After this and on all subsequent washdays, use the recommended amount of soap and two to four tablespoons of washing soda.

In addition to cutting pollution by use of a biodegradable soap, watch the consumption of gas and electricity in the laundryroom. Clothes dryers are heating units. As such, they are one of the greatest users of energy. If you have a clothesline use it. If you don't have one, put one up and then use it. Save the dryer for emergencies and rainy days, if you must own one at all.

The Closet

Clothing is made from natural resources. As such, it should be conserved. Wear your clothes out. When they are beyond your own attempts at repair, give them to a local charity organization which will keep them in circulation. Consider what each article of clothing is made of. Cotton, wool, linen and leather are renewable resources. Synthetic fabrics are produtts of fossil fuel, a limited resource. Do not take these facts lightly. Shop carefully for clothing which will last and thus help you lessen your impact on the environment.

Never buy wild animal furs or skins. Only those skins and pelts of animals raised for food or fur are suited for human use. We have been careless and even merciless in our pursuit of wild animals for our selfish profit.

The Bathroom

Water is probably the major resource used in the bathroom. Simple habits of conservation can be observed here to decrease the amount of water you waste. Do not leave the water running while you brush your teath. Don't shower daily unless you are really dirty. The amount of water wasted every time you flush the toilet (usually five gallons) can be decreased by placing a brick or two in the tank. Or get a plumber friend to show you how to make the water level adjustment inside the tank itself. Use towels more than one time to decrease the laundry. Another means of conserving water is, of course, pollution prevention. Once again, Amway LOC and Shaklee Basic-H provide biodegradable general cleaning. Do not use colored toilet paper as the dyes do not break down in water.

The bathroom provides an opportunity for you to use animal fat you have been saving. Here is a recipe for homemade soap:

1. Pour 1 cup cold water into a jar. Add 5 tablespoons lye (be very careful of spillage). Mix over sink until dissolved and clear. Let set for a few minutes.

2. Put 3 cups of any lard or animal fat drippings in blender. Pour lye over fat. Turn on low, then high. Blend well until thickened. Pour into pyrex cake pan and let set for several days. Cut into bars and store in air tight containers.

3. This soap is perfect for hands but may also be shredded for laundry or dishwashing.

The Livingroom

Share magazines with your neighbors. It is ridiculous for everyone on a block to subscribe to the same magazines. Better yet, buy no magazines at all; read all the latest issues at the public library. The same applies to newspapers. If you buy them, save and recycle them. When you have saved about one hundred pounds of newspapers, take them to a local collection center.

Always keep in mind the reason for conserving paper: There are 17 large trees in one ton of paper. Paper is trees! Trees provide beauty, recreation, flood control, oxygen, homes for wildlife and lunber. Clear cutting a forest to yield paper is a waste, especially when you and I continue to put out five pounds of trash daily, most of it paper. When you set an example by your lifestyle in such areas as paper recycling, you will be making an important contribution to reversing the dangerous trends which are prominent today. In addition, always turn off lights in the livingroom when you are not using them, turn down the heat and put on a sweater; every little bit helps, especially in setting a good example.

The Garage

Your garage houses a potential killer. Diminish the danger to all of our lives by considering your car a dinosaur and looking into better and more healthful modes of transporation. Cars are the leading producers of air pollution, and smog kills. Because of the influence of smog on the occurence and worsening of chronic respiratory diseases and heart diseases, doctors advise over 10,000 persons each year to move from the Los Angeles area. Do something about it. Drive as little as possible. Ride a bicycle, walk, and run wherever you can. These activities are far more healthful than driving a dinosaur. When use of a motor driven vehicle is inescapable, make the most of the energy and resources involved in making it go. Take a bus, form a car pool, drive only small cars which are well tuned and use detergent gasoline. These measures will help to minimize your individual output of smog, though they will not, of course, eliminate the problems inherent in automobiles.

The car is becoming a political issue. People are finally becoming tired enough of poisonous smog, noise, asphalt, congestion, expense and confusion to take action. Join in this action by refusing to buy a new car. Think about it. If there were no new cars sold on the American market in just one year, industry would be forced to find an answer to the problems which are killing us.

The petroleum products we pour into our cars are non-renewable resources. Their haphazard consumption in cars is wasting their life-giving potential. We are wasting our natural resources.

The Garden

Green plants of any kind around your house are valuable for their beauty and oxygen. If you don't have enough trees, plant one or two. At Christmas time, buy a potted tree and plant it later. If you have room for a vegetable garden, use that space for organically grown, insecticide free, fresh vegetables. If you live in an apartment and don't have yard space, take advantage of your window sills, shelf tops and anywhere else you can find to grow herbs and spices in pots.

The garden provides a useful disposal for your food scraps and garbage. Start a compost right away by burying food scraps and leaves and grass clippings about six inches below the ground. You may wish to collect some compostables before starting the actual compost. Covering food scraps with dry leaves makes this

possible as it keeps away flies and dispells odors. When you do start the compost, be sure to use enough dirt to prevent detection by animals. A fine organic fertilizer can be made by mixing earth, ground garbage and manure. Contact a local dairy farm or horse stables for free manure. This is rich in the nutrients plants need without adding residual chemicals. A thin layer of rotting leaves around the base of your plants will also do much to discourage weed growth.

Talk to the proprietors of your local nursery about what vegetables prosper best in your particular area. Grow several different kinds of vegetables; variety discourages infestations as not all insects feed on the same plants. Some types of plants such as mint, marigolds, onions, herbs and speices act as repellants to insects. Fool insects by planting either as late or as early in the season as possible and change the arrangement of your planting from season to season.

There are many species of insects which are beneficial to your garden. Make your garden attractive to these predators by providing hiding places for them. Ground beetles, which feed on cutworms, snails and slugs, need hiding places during the day. Don't be over enthusiastic in your weed control. Weeds provide hiding places and pollen sources for beneficial insects. Birds too are an important insect control. Tank vegetation provides escape cover for them. Dogs and cats will have to be restrained if a number of birds are to be attracted to your garden. Predatory insects include the green lacewing, preying mantis, convergen and vedalia lady beetle and the trichogramma. Aid these species by washing as well as watering the plants, providing a water source and maintaining organically rich soil.

Be realistic; some insect attack will occur in the best organic garden. Salvage damaged fruits and vegetables. Cabbage, artichoke, head lettuce, etc. are usually damaged only on the outer leaves, corn only at the tip, apples only at the core. These "worms" are harmless.

Snails and ants provide specific problems because they are very competitive and have few natural enemies. Since snails feed at night, they can be hunted with a flashlight. Encourage them to congregate by leaving a few burlap bags in the garden, then crush them. Saucers of beer or vinegar left flush with the ground, attract snails and drown them. Once the garden has been cleared of snails, block off further entrance with a line of sawdust. When bait must be used, Matal-dehyde is arsenic free.

Ants are generally a detriment to the garden as they nurse and protect aphids and mealy bugs. They can be kept off larger trees and shrubs by ringing the trunk with Stickem, Crawlz No More, Tanglefoot or Ready Made Tree Bands. Smaller plants can be washed off with water blasts whenever the problem develops. Aphid attack is discouraged by planting garlic or onion near the host plant. When ants are kept off, aphids and mealy bugs should also greatly decrease. Destroying worker ants will never alleviate the problem for long periods of time. If you find the nest in your yard or garden, it may be destroyed by pouring 1-2 tablespoons of carbon bisulphide and then covering up the site with dirt. If you have a problem with ants but cannot find the nest, try cutting off the line of foragers with vaseline at their entrance to your garden. Or the trail may be sprayed with kerosene. If you still can't find the nest and delusion measures fail, lure the colony by mixing honey and soil in a flower pot and placing it on the trail; when the queen moves in, destroy the colony. Use baits such as Grant's Ant Stakes only when all else fails and remember to place all poisons out of the reach of children and pets. When ants are really no problem, do not destroy them. Where aphids and mealy bugs are not present, let the ants alone. Their tunneling and nest building aerates the soil and brings minerals to the surface.

"Pesticides" is a general term for any material (usually chemical) used to kill insects, weeds or fungi. The weed killers or herbicides have no place in the organic garden. Pull unwanted weeds by hand from among flowers and vegetables. If you find you cannot grow a lawn without herbicides, then plant trees and shrubs. Herbicides have been spread freely for 25 years. We have learned that one of the commonest, 2,4,5,-T, has cancer forming potential. Do not contribute to the danger.

There are chemical products on the market which you should avoid at all costs. Read all labels of insecticides which you are considering for use and do not purchase or use any of the following: DDT, DDD, Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Kelthane, Lindane, Ovex, Tedion, Thiodan, Toxophane or any chlorinated hydrocarbons. These poisons are not biodegradable. They are magnified by passing from one link in the food chain to the next. This type of poisoning the whole landscape, including most definitely ourselves, has been one of the greatest ecological blunders of this generation. Do not contribute to it further. An organic garden provides you with poison free vegetables, alleviating your consumption of one of your sources of poisoned links in the food chains.

When you feel that you have a real problem in the garden and organic methods have failed, try a soapy water spray or light oil. If these too fail, stop to consider the possibility that the infested vegetable simply may not be suited to the conditions of your immediate area.. Composting or plowing under the failing crop may be a better solution than getting into a pesticide syndrome. There are relatively safer chemicals on the market which can be used to help get you out of an exceptionally tight spot. These are non-residual but are potentially dangerous if used carelessly. Limit your usage to a small area and read all instructions carefully. Powders are generally safer than sprays. Vegetable extracts include pyrethins, rotenone and nicotine sulphate. Chemical compounds which are thought to be relatively safer include Diazinon, Malathion, Dibrom, Sevin, si syston and metasystox R. These are still somewhat experimental, however, and should not be used on vegetables.

When your garden and yard are prospering under organic care, you will probably want to spend more time out of doors. Patio furniture is often, unfortunately, made of redwood. Redwood furniture has always been desirable because of its durability out-of-doors. It is a good deal more useful growing in the forest than furnishing your patio. Lumber other than redwood can be preserved for outdoor use by application of a wiping stain from a hardware store and a mixture of one part log oil, one part turpentine. If you don't buy redwood lumber or products then there is no demand and thus it will be uneconomical for the timber industry to cut and destroy a world resource; the redwood forest, only found in California. Efforts such as this on your part can help to preserve our redwood forests for our children and our children's children.

For further methods and practices of organic gardening, borrow these books from the public library or add them to your own ecology library.

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Magazines available include:

Organic Gardening and Farming, Compost Science, Mother Earth, and Prevention.

Remember: only your own living and buying habits will reclaim this planet; only your letters and votes will force politicians to place life over lobbies; only your buying power will convince industry that a dead planet is bad for business.

Section IV

CONCLUSION

It should be emphasized that environmental action projects should be enjoyable learning processes with a worthwhile and positive goal. It is questionable if students should be "required" to participate; rather these suggestions can serve as a step toward learning by doing, and not just doing because it is required and for a reward such as some grade on a report card. Certainly the reward gained from satisfactory experiences in environmental action is relevant to each student as he tackles the problem of his and mankind's survival in a crumbling ecosystem.

The key to environemtnal degradation, of course, is consumption. We have prided ourselves in the past on our national material consumption rate. This is often called our expanding Gross National Product. Now we must consider changing this philosophy of materialism. We must work very hand to insure that each time a member of our society buys a product he really needs that product. We must learn to consume only those material goods absolutely necessary for daily living. If you really succeed in getting your students to be lesser consumers upon the limited natural resource base of our country than generations of Americans have been in the past, then we may have a chance at a liveable environment.

Finally, we must face the task of evaluating our environmental action unit. While addressing the issue of evaluation and seeking ways of measuring school effectiveness we might ask:

1. Do the children initiate activities? Are they self-directing? Do they take responsibility for their own learning? How do we as teachers implement this?

2. Are children capable of intense involvement? Does their curiosity often lead to concern, and beyond concern to commitment?

3. Do children continue to wonder and to imagine, and do they bring their sense of humor into the classroom?

4. Are children willing to face uncertainty and change, and to tackle complexities that they have not been taught to manage? Are children unafraid of being wrong?

5. Do our children challenge ideas for the purpose of reaching deeper understandings? Are they open and honest with themselves, with adults and with each other?

6. Do children respect themselves, others and the environment? Are they learning responsibility as an integral part of freedom?

7. How do we, as teachers, design a curriculum which will facilitate these concepts?

ENVIRONMENTAL EDUCATION PROGRAMS
IN MONTANA PUBLIC SCHOOLS

1. The Great Falls Public Schools operate conservation and summer camping programs. These programs include extensive outdoor experience. The operation was originally funded by ESEA Title III and is now funded by the local school district. For more details, contact Calvin Ryder, Director of Environmental Education, Great Falls Public Schools, Great Falls, Montana 59401.

2. The Missoula County High Schools operate a conservation education program. This school system owns an outdoor laboratory facility of approximately 100 acres which is in the process of development and appears to have excellent possibilities. The program was originally funded by ESEA Title III and is now funded at the local level. The director is Harold Knapp, Missoula County High School, Missoula, Montana 59801.

3. Deer Lodge Public Schools, Deer Lodge, Montana 59722, have a high school level conservation program and also operate the Powell County Environmental In-Service Curriculum Center which currently is funded by ESEA Title III. The high school program is involved in an interesting study of the Pronghorn (American antelope) and the ecological community in which this mammal exists. Gary Swant is the director.

4. The Cut Bank Elementary Schools, Cut Bank, Montana 59427, have a conservation program which is funded at the local level. This program, in cooperation with the National Park Service, has structured an excellent outdoor experience in Glacier National Park during which students study a myriad of eco-systems from pond communities to alpine communities. For details, contact Miss Verna Rasmussen, Principal, South Side School.

5. The Alberton Elementary School, Alberton, Montana 59820, operates an outdoor education program which focuses on the local environment (a mountain river valley west of the Continental Divide). The program was originally funded by ESEA Title III and is now funded at the local level. Details can be obtained from the principal, Alberton Elementary School.

6. The Columbia Falls Elementary School, Columbia Falls, Montana 59912, operates an outdoor education program for sixth grade students. This program is funded at the local level. Information is available by contacting Roy Wendt, Principal, Columbia Falls Elementary School.

7. The Billings Public Schools, Billings, Montana 59102, operate an environmental education program which includes an outdoor education experience which resulted from five pilot programs conducted from the 1967-68 school year through the 1970-71 school year. The program began in cooperation with the Eastern Montana College Laboratory School, Billings. The outdoor experience is now conducted in the Rock Creek Valley in the Beartooth Mountains near Red Lodge, approximately 60 miles from Billings. At the termination of the 1970-71 school year, the program had reached approximately 65 percent of the sixth grade students in the school system. More details are available from Mr. Edward A. Heiser, Assistant Director, Environmental Education.

8. The Hamilton Public Schools are integrating environmental concepts with existing curriculum offerings in grades 1-12. An ESEA Title III project offers a variety of curriculum aids and resource personnel for use by teachers and students. An outdoor study area, complete with an observation building,

is an integral part of the project. Additional information is available by contacting Mr. Ron Skelton, Title III Project Director, Hamilton Public Schools.

9. The Helena High Schools operate Project 180 for 40 academically despondent, potential dropout sophomores who study English, science, social studies, art, mathematics and physical education through outdoor activities. One hundred and eighty days are spent out of doors with students operating from base tent camps, promarily on 4,000 acres of diversified land near Priests Pass. The land was made available through an agreement between the school district and the Helena National Forest. Financing of $33,130 was provided by the Helena Model City program and in-kind services are provided by the school district. It is hoped that the program can be expanded to include average and more successful students. Further information is available from Terry L. Beaver, director of environmental-outdoor education, Helena Senior High School, Helena, Montana 59601.

Commendable programs in environmental education probably exist in other schools throughout Montana. An objective of the Office of the Superintendent of Public Instruction is to identify such schools and, as a source of communication, enable other schools to learn where useful, exemplary programs are in operation.

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Science Curriculum Improvement Study (Elementary Science) Rand McNally & Co.

FILM BIBLIOGRAPHY

See page 252 for code explanation

Above the Timberline, color, 15 min. - McG
Acorns: Staple Food of California Indians, co pr, 28 min.
Adaptive Radiation - The Mollusks, color, 18 min. - EB
Age of the Buffalo, color, 14 min. - EB
Balance of Life and the Space Age, color, 14 min. - FA
Birds of the Countryside, color, 11 min. - COR
Birth of the Soil, color, 11 min. - EB
Brazil: The Gathering Millions, b/w, 60 min.
Buckeyes: Food of the California Indians, color, 13 min.
By Land, Sea, and Air, color, 31 min. - OCA
Cars in Your Life, The, color, 30 min. - CF
Changing Forest, The, color, 19 min. - McG
City - Cars or People?, The, b/w, 27 min. - CF
City of Necessity, color, 30 min. - CF
Community, The, color, 11 min. - EBF
Cry of the Marsh, color, 20 min. - Bill Snyder Films, Box 2784, Fargo, N.D. 58102
Dead Birds, color, 83 min. - McG
Disaster at Dawn, b/w, 27 min.
Distribution of Plants and Animals, color, 16 min. - EB
Dust Bowl, b/w, 26 min. - McG
Environment and Survival: Life in a Trout Stream, color, 10 min. - FA
Fire Lookout, color, 13 min. - IFB
Forest, The, color, 29 min. - USDA
Forest Grows, The, color, 33 min. - EB
Forest Produces, The, color, , - EB
Germ and Chemical Warfare, b/w, 30 min.
Glen Canyon, color, 29 min. - SC
Grand Canyon, The, color, 26 min. - SC
Grasslands, The, color, 17 min. - EB
Heart of the City, b/w, 27 min. - CF
Heritage We Guard, A, b/w, 30 min. - USDA
High Artic Biome, The, color, 22 min. - NFBC
House of Man--Our Changing Environment, color, 17 min. - EB
How Things Get Done, b/w, 30 min. - CF
How to Live in a City, b/w, 30 min. - CF
How to Look at a City, b/w, 30 min. - CF
Island in Time, An, color, 28 min. - SC
Interrelationships for Survival, color, 28 min. - McG
Life in the Deciduous Forest, color, 19 min. - CAMPF
Life in the Desert-North America, color, 11 min. - EB
Life in the Forest-North America, color, 11 min. - EB
Life in the Grasslands, color, 11 min. - EB
Life in the Woodlot, color, 17 min. - NFBC
Life Story of the Oyster, color, 11 min. - EB
Living Forest Series, USDA Limiting Factors, AIBS
Man Makes a Desert, color, 11 min. - FA
Man's Problem (Water Supply), color, 20 min. - EB
Marine Ecology, color, 28 min. - AIBS
Marine Science Series, color, 4 films - McG
Multiply and Subdue the Earth, color, 60 min. - AVC
Nature Next Door, color, 28 min. - SC

Noise: New Pollutant, b/w, 30 min.
No Room for Wilderness?, color, 28 min. - SC
Patterns of Energy Transfer, color, 28 min. - AIBS
Physical Environment, The, color, 11 min. - EB
Plague on Your Children, A, b/w, 72 min. - BBC
Plant-Animal Communities - Changing Balance of Nature, color, 11 min. - COR
Plant-Animal Communities - Physical Environment, color, 11 min. - COR
Plant Succession, color, 15 min. - McG
Poisoned Air, The, b/w, 50 min.
Polar Ecology, color, 22 min.
Population Ecology, color, 28 min. - AIBS
Population Ecology, color, 19 min. - McG
Realm of the Wild, color, 28 min. - DUART
Redwoods, The, color, 39 min. SC
Redwood Trees, color, 15 min. - BARR
Regenerative Processes, color, 20 min. - NASA
River, The, b/w, 32 min. - DUART
Sea, The, color, 26 min. - EB
Sea Otters of Amchitka, color, 45 min. - SC
Science Conserves the Forest, color, 15 min. - EB
Seeds of Destruction, color, 10 min. - EB
Silent Spring of Rachel Carson, b/w, 54 min.
Spirit of '76 (Santa Barbara oil slick) - ADF
Strands Grow, A Strand Breaks, color, 2 films, 15 min. ea., - LB
Succession from Sand Dune to Forest, color, 17 min. - EB
Though the Earth be Moved, b/w, 45 min.
Two Yosemites, color, 14 min. - SC
Vanishing Birds, color, 11 min. - PIC
Wasted Woods, color, 15 min. - SC
Way of Life, A, color, 28 min. - MOCC
What is Ecology?, color, 11 min. - EB
What Will You Tear Down Next?, b/w, 30 min. - CF
Wilderness Alps of Sthehekin, color, 30 min. - SC
Wilderness Trail, The, color, 15 min. - USDA
Wildlife and the Human Touch, color, 19 min. - DUART
World in a Marsh, color, 22 min. - NFBC
Feeding the Billions, color, 54 min. - McG
Spruce Bog, color, 28 min. - McG
Energy Relations, color, 28 min. - McG
First Mile Up, _____, - McG
Who Killed Lake Erie?, color, 54 min. - Audio Visual Instructions, Corvallis, Oregon
Ill Winds on a Sunny Day, color, 54 min. - National Audio-Visual Center, Washington, D.C. 20409
Free films from U. S. Public Health Service-Communicable Disease Center (A.V.) Atlanta 22, Georgia

MIS - 673, Ill Winds, Ill Water, b/w, 28 min.
MIS - 674, The City's Future, b/w, 28 min.
MIS - 675, Channel 4 Reports, b/w, 28 min. New Orleans
MIS - 676, Control of Air Pollution, color, 5 min.
MIS - 677, Sources of Air Pollution, color, 5 min. Series
MIS - 678, Effects of Air Pollution, color, 5 min.
MIS - 683, Our Poisoned Air, b/w, 28 min. CBS General
M - 696, Expedition: City Fallout, b/w, 28 min.
MIS - 749, Is Our Sky a Sewer?, b/w, 28 min. Discussion
MIS - 773, Take a Deep Breath, b/w, 28 min.

MIS - 974, Let's Clear the Air, b/w, 28 min.
MIS - 679, Breathe at Your Own Risk, b/w, 58 min.
MIS - 985, Pall Over Our Cities, b/w, 15 min.
M - 1418-X, The Poisoned Air, color, 50 min. CBS General
M - 1419-X, Air of Disaster, color, 50 min. L.A. - Denver
TFE - 1308-X, Something in the Wind, b/w, 30 min. Kansas City
M - 1430-X, With Each Breath, color, 30 min. New York
MIS - 985, Pall Over America, b/w, 15 min. Summary
M - 1420-X, The Business of Air, color, 30 min. St. Louis
AM - 1404, The Third Pollution, color, 23 min. Solid Waste
M - 1431-X, It's the Only Air We've Got, color, 25 min. Pittsburgh

Free Films from Shell Oil Company, Shell Film Library, 450 No. Meridian St., Indianapolis, Indiana 46204

Food or Famine, color, 28.5 min.
The River Must Live, color, 28 min.

FILMSTRIPS

Environmental Pollution: Our World in Crisis
Set of 6 filmstrips, total 414 frames, all in color, 16 pages of Teaching Guide. (Wards: 70W 3800)

1. Nature of the Crisis
2. Atmospheric Pollution
3. Land Pollution
4. Fresh Water Pollution
5. Marine Pollution
6. Pollution Control

The Environment of Man, An Introduction to Ecology
Four Filmstrips and Records
1. What is Ecology?
2. What Is an Ecosystem?
3. How Does Nature Change Ecosystems?
4. How Does Man Change Ecosystems?
(Educational Coordinates, 432 Pastoria Avenue, Sunnyvale, California 94086 cost $44.60)

Sources of Films and Materials

ADF	American Documentary Films 336 W. 84th St. New York, New York 10024
AIBS	American Institute of Biological Science 2000 P. St., N. W. Washington, D. C. 20006
AVC	Audio Visual Center Indiana University Bloomington, Indiana 47401
BARR	Aurthur Bau Productions 1029 No. Allen Ave. Pasadena, California 91104
BBC	British Broadcasting Corp. Peter M-Robeck and Co. 230 Park Avenue New York, New York 10017
COR	Coronet Films 65 E. South Water Street Chicago, Illinois 60601
DUART	Du Art Labs. Inc. 245 W. 55th St. New York New York 10019
EB	Encyclopedia Britannica Films Inc. 1150 Wilmetter Ave. Willette, Ill. 60091
EH	Educational Horizons 3015 Delores Street Los Angeles, California 90025
FA	Film Associates of California 11014 Santa Monica Boulevard Los Angeles, California 90046
IFB	International Film Bureau 332 S. Michigan Ave. Chicago, Ill 60604
McG or CF	McGraw-Hill Text Films 330 W. 42nd Street New York, New York 10018
NASA	National Aeronautics and Space Administration 1520 H. Street Washington, D. C. 20025

NDBC	National Film Board of Canada 680 Fifth Avenue New York, New York 10019
OCA	Oil, Chemical and Atomic Workers International Union 1126 16th St., N.W. Washington, D. C. 20036
PIC	Pictura Films Corporation 29 East 19th Street New York, New York 10003
SC	Sierra Club - Association Films 600 Grand Avenue Ridgefield, New Jersey 07657

SOURCES OF RESOURCE PERSONNEL FOR ASSISTING WITH ENVIRONMENTAL EDUCATION

This appendix lists local, state and federal agencies which usually have personnel available to assist with environmental education programs and projects. This list is not necessarily complete. Your particular area may have access to other institutions with one or a limited number of offices in the state. An example of this would be the Rocky Mountain Laboratory at Hamilton. You are encouraged to seek the services of anyone who can help with your teaching activity.

When an agency has more than one office in the state the title of the official to contact is listed in parenthesis following the agency name. Agencies are listed in the telephone directory alphabetically under Montana, State of, or U.S. Government.

Local

- City or County or City-County Health Department
- City Water Department
- Community and Private College
- County Commissioners
- County Sanitarian
- County Superintendent of Schools
- County Weed Districts
- Soil and Water Conservation Districts

State

- Montana Department of Lands and Investments
- Montana Department of Public Instruction
- Montana Experiment Station
- Montana Fish and Game Department
- Montana Forestry Department
- Montana Highway Commission
- Montana Water Resources Board
- University of Montana (all Units)

Federal

- Agricultural Stabilization and Conservation Service (County Office Director)
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Sports Fisheries and Wildlife
- Cooperative Extension Service (County Agent)
- Forest Service (District Ranger)
- Rural Electrification Administration
- Soil Conservation Service (District Conservationist)

There are other private or semi-public groups which may be able to give assistance. They include:

- American Society of Range Management - Intermountain and Great Plains Sections
- Society of American Foresters
- Montana Chapter - Soil Conservation Society of America
- Montana Congress of Parents and Teachers
- Montana Conservation Council

Locally there may be other groups as well as private companies and corporations with assistance to offier. The ingenious teacher can usually find many sources of assistance near.

PARTIAL LIST OF NONGOVERNMENTAL ORGANIZATIONS INTERESTED IN CONSERVATION

American Conservation Association, Room 5600, 30 Rockefeller Plaza, New York, N. Y. 10020
Supports specific projects dealing with the conservation of natural resources.

American Forest Products Industries, Inc., 1816 N Street, N. W., Washington, D. C. 20036
Provides literature, program suggestions and teacher's kit on forest conservation.

The American Forestry Association, 919 17th Street, N. W., Washington, D. C. 20036
Publishes American Forests magazine and conducts educational activities in the broad field of forest conservation.

American Planning and Civic Association, 901 Union Trust Building, Washington, D. C. 20005
Publishes Planning and Civic Comment magazine and promotes planning for best use of urban and rural land at local, state, regional and national levels.

American Society of Range Management, Box 5041, Portland, Oregon 97213
Professional society interested in greatest sustained use of forage and soil resources.

Citizens Committee on Nautral Resources, 710 Dupont Circle Building, Washington, D. C. 20036
Seeks to influence legislation in behalf of conservation.

Conservation Education Association, Wisconsin Conservation Department, Box 450, Madison, Wisconsin
Publishes Conservation Education Bulletin, and promotes research and education in the broad field of conservation.

The Conservation Foundation, 1250 Connecticut Avenue, N. W., Washington, D. C. 20036
Promotes research and education and issues publications in the broad field of conservation.

Defenders of Wildlife, 809 Dupont Circle Building, Washington, D. C. 20036
Issues a news bulletin and wildlife educational publications.

The Izaak Walton League of America, 1326 Waukegan Road, Glenview, Illinois.
Conservation Director, Room 509, 719 13th St., Washington, D. C. 20005
Publishes the Izaak Walton Magazine, Outdoor America and miscellaneous pamphlets, and has a nationwide program for the promotion of conservation.

National Association of Soil and Water Conservation Districts, 500 Realty Building, Washington, D. C. 20005

National Audubon Society, 1130 Fifth Avenue, New York, N. Y. 10028
Publishes Nature Centers Division conservation education guidebooks and other literature, Audubon Magazine, Audubon Nature Bulletins and Charts and Audubon Leader's Conservation Guide; operates an Audubon Junior Program and Audubon Camps; and provides audio-visual aids.

National Parks Association, 1300 New Hampshire Avenue, N. W., Washington, D. C. 20036
Publishes National Parks magazine; has motion-picture rental library list.

National Wildlife Federation, 1412 16th Street, N. W., Washington, D. C. 20036
Publishes National Wildlife magazine; Conservation News, Conservation Report; conservation education booklets and bulletins; distributes wildlife conservation stamps and albums.

The Nature Conservancy, 1522 K Street, N. W., Washington, D. C. 20005
Publishes Nature Conservancy News and Information Bulletins; preserves natural areas.

Resources for the Future, Inc., 1755 Massachusetts Avenue, N. W., Washington, D. C. 20036.
Publishes books and news letters resulting from research findings; helps finance research by other agencies.

Save-the-Redwoods League, 114 Sansome Street, San Francisco, California 94104
Promotes the purchase of redwood groves.

Sierra Club, Mills Tower, San Francisco, California 94104
Publishes Sierra Club Bulletin and Sierra Club Exhibit Format Series; engages in a wide range of conservation activities.

Soil Conservation Society of Ameria, 7515 N. E. Ankeny Road, Ankeny, Iowa 50021
Publishes Journal of Soil and Water Conservation and booklets for young people.

Sport Fishing Institute, 719 13th Street, N. W., Washington, D. C. 20005
Issues SFI Bulletin and special publications.

The Wilderness Society, 729 15th Street, N. W., Washington, D. C. 20005
Publishes The Living Wilderness magazine and other literature.

SURVEY OF ENVIRONMENTAL CURRICULA

Larry Dvorak and Roberta Dvorak

Introduction

This is a survey of several of the environmental education curricula and teaching guides available to elementary school teachers. These curricula are strongly based in the sciences and social sciences but other subject areas also are considered.

The Environmental Awareness Program

Menesini, Marie, The Environmental School, 1970. Education Consulting Service, 372 Village Square, 89 Orinda Way, #6, Orinda, California 94563

The Environmental Awareness Program (EAP) is specialized environmental education. EAP uses outdoor areas -- called Environmental Awareness Sites (EAS) as well as class work to examine the interactions of air, earth, water and populations in both natural and man-made environments.

The program clearly defines objectives at all grade areas. It defines an environmental awareness site and gives clear directions as to the choice, development and use of the site and the personnel required. Various types of sites from a metropolis to a desert are described with some guide lines for their possible use.

An environmental awareness program is developed with project ideas such as developing an outdoor classroom, making an environmental trail (either nature or rural), and taking a field trip. Ideas for a several-hour or day-long field trip and ideas for a more extensive environmental research field trip are particularly well developed.

The program is set on three levels. For younger students in the elementary grades, the program hopes to develop an appreciation for the environment, either natural or man-made. A sense of the utilization of elements of the environment is the aim of junior high students. High school students are beginning to look at the world they will face as adults. The goal for these students is to encourage an "environmental ethic" stressing positive action in the use and improvement of the environment.

The program is not based solely on science but is specifically concerned with interweaving all of the traditional school courses into an environmental awareness program. Specific ideas for discussion and action for the three age levels in the areas of art, communication, mathematics, science or social studies are given.

A glossary is provided. A bibliography of book materials is also presented.

Minnesota Environmental Education Program

A collection of 13 sample units written in response to a mandate from the Minnesota State Legislature (March 1969) which made provisions for developing and implementing a statewide program in Environmental Education is in an experimental phase.

The collection includes one sample unit for each level K-12. It is not oriented toward one particular subject area, but is developed to provide a worthwhile experience for the student. Teachers are encouraged to modify or adapt the program to fit the students' particular needs. Although the units are aimed at specific levels, they can be put to use at other grade levels with some modification.

Exercises in the units are to be used in a discovery approach whereby the child may learn from doing rather than be being told. Teacher background, materials and plans are given on white pages. Specific student instructions, data sheets, etc. appear on yellow sheets.

The general trend of the units is a study of the social or cultural environment and the effects of the physical environment upon it.

K- presents a stress on reasoning and observation skills. It helps students become aware of associations hetween a symbol and an event, then be able to predict an appropriate outcome.

1- Collecting and collections. Includes activities and field trips to make collections, activities to follow up, some for specific use of skills with collections, some "just for fun."

Level 1- Verbal skills
Increase vocabulary, expressing self in high interest situation
Level 2- Differentiation skills with colors, textures, relative size, odors, shapes, life forms, non-living substances, sounds.
Level 3- Relationship recognition
Between collections, within components of a collections, between collection and environment from which it was removed

2- Concern and care for plants and animals is used as a vehicle for learning language arts skills. Sensitivity to their environment serves as a basis for the children's oral and written skills. Daily observations are made and the children should feel free to espress themselves about their activities. The activities are concerned with allowing the children to discover the needs and requirements of several different organisms, allowing experimentation without endangering the life of the organism.

3- A collection of progressively more difficult activities to help the child become aware of the social and physical aspects of his environment, their relationship with each other and his interaction with them. Activities begin in a small area (such as the school ground) with which the child is familiar, progress to the community, to less familiar areas and finally end with the conclusion that man can determine some of the conditions of his world and that he can change the physical or social environment.

4- Litter or waste is the product of all living things. Activities guide the child to document this concept by direct observation and measurement as it occurs with plants and various forms of animal life. Man is shown as a litter producer and the problem is presented as to what actions are necessary to keep the quantity and kind of litter in balance with ecological and social values.

5- Gives students experience in detecting the environmental factors (particularly climate) which affect our comfort and the ways in which we modify our immediate environment. The activities are intended to develop an understanding of environmental health. The varied activities give experience with heat, air movement, sound, electricity, insulation, itc. as they are important to house builders or architects.

6- A cook-out fire or overnight camping experience provides development of a unit on fire. Many aspects of the "wilderness environment" are brought into the unit such as wild foods, decomposition and the effects fire has on the organisms in an area. Scientific aspects such as the heat of a fire or organisms found in the soil are brought in. Concern is also given to building a fire and to the social and economic aspects of fires.

8- Survival techniques in society dealing primarily with purchasing or producing are introduced. Activities involve planning a lunch on a set budget, observing quality, cost per ounce and setting up a "mini-business." Activities are designed to interest both boys and girls.

10- The distinction between physical and cultural environment and an understanding of the ways cultural groups react to their physical environment are preserved. The students study aspects of community interaction, cultural effects on community design, community attitudes, transportation and land use, and the community's use of environment.

Community Action for Environmental Quality

The Citizens Advisory Committee on Environmental Quality, 1700 Pennsylvania Avenue, N.W., Washington, D.C. 20006

This is a guidebook to aid the organization of community projects dealing with environment problems. It is primarily concerned with the development or renovation of available land for the public's use. It suggests city, county and federal agencies that might help provide plans or funding, describing various kinds of zoning as well as several types of land use projects that can be developed. Project ideas are given for city beautification and pollution control as well as ideas for training and involving young people of the community.

It can serve as a project guide for teachers as members of the community or to guide a student project.

The Environmental Studies Project

The Environmental Studies Project is sponsored by the American Geological Institute, National Science Foundation. Additional grants from Polaroid Corporation, Co. 1970, American Geological Institute. Write: ESCP, Dorothy Curtis, Assistant Director of Environmental Studies, Box 1559, Boulder, Colorado.

This program aims to develop trust and some degree of freedom between the students and the teacher. It was developed to help students learn to think on their own and to feel good about it. It presents the teacher as a human.

It consists of a series of 26 one-page inquiry exercises dealing with using, or thinking about, various elements of the natural and manmade environment. Each exercise consists of a short explanation of the activity for the students, some followup activities, and some notes to the teacher.

Examples: "Ask the students to make a list of 10 things in their enviroment that can't be photographed; then have them go outside and photograph any three of them." "Map the flow of people in the school." "Go outside and prove that some living thing in your environment changes." Go outside and map something you cannot see." "Go outside and find a million of something and prove it."

It gives a chance for the teacher to get the students out of the classroom and on thier own. These few can provide a start for a more free classroom or a break in the routine.

Science Curriculum Improvement Study

Rand McNally and Company, 1970. P.O. Box 7600, Chicago, Illinois 60680

The SCIS Elementary Science Sourcebook contains information about the SCIS program of physical and biological sciences. The philosophy, goals and suggested teacher approaches to the program are given. Notes for the instructor are included along with several sample exercises.

The biological sequence includes organisms- life cycles- populations- environments- communities- ecosystem in a six-year program. Materials for the units can be ordered through the company. It provides teacher plans for each major activity with bachground information, objectives, materials, preparation, care of organism and many teaching suggestions.

The unit guides children through exploration, invention and discovery to an understanding of the characteristics or processes common to all living things and the distinctions between living and nonliving objects.

The program encourages interaction between the children and the objects or events and between each other. The teacher's goal is to promote curiosity, discussion and investigation.

Materials for the program are listed along with some applicable film loops. A chart is also shown which plans the starting time and length devoted to each chapter. Teachers are encouraged, however, to spend more or less time as they see fit with any particular aspect or to use the activities to the best advantage of the class. The exercises could be adapted to any grade level.

Organisms gives the children first-hand experiences with the birth, growth and death of plants and animals. Both terrestrial and aquatic organisms are studied as plants are grown and guppies, snails and daphnia are observed from birth through death.

Life Cycles Part I deals with plant life cycles from determining the source of seeds, to planting, growing and finally answering some questions about plants.

Part II contains exercises on animal life cycles with fruit flies, frogs and mealworms. Part III presents the concept of biotic potential in plants and animals. Part IV discusses genetic identity, distinctions between plants and animals and determination of what is living and non living.

Populations follows the same general goals and format as the Life Cycles unit with emphasis on populations and some relationships within the population. The students first set up fresh water aquaria for populations of daphnia, hydra, duckweed. They observe separate populations of daphnia, aphids and fruit flies to learn the importance of food supply, living space and reproduction in relation to the increase or decrease in size of population. Food relationships are first considered when the students find that the population of daphnia is smaller in aquaria containing both hydra and daphnia than it is in aquaria containing only daphnia.

The students will also build terraria and observe the effect of a cricket population on a plant population and then the effect of a chameleon population on crickets to introduce predator-prey relationships.

Finally, the concept of food webs is developed then extended to outdoors where the idea of a community is developed.

Environments follows the same general format with a student manual for individual observations.

Students begin by building terraria according to their preconceptions of the needs of the organisms and varying degrees of success will occur. The concept of environmental factors is introduced. The students construct a temperature gradient to test the range and optimum range of the organisms.

A study is initiated then to aid the children in learning about particular environments of isopods, snails, beetles and brine shrimp. Plants are then studied to determine their response to light, temperature, water and chemicals. With this knowledge at hand, the students again construct terraria.

Communities investigates plants to find that they produce food for their own growth and development as well as for the support of plant eating animal populations. Meat-eating populations are also introduced. Decomposition of dead organisms is seen as the raw materials are returned to the environment and then taken up again by plants. The interdependence of these three groups (the producers, consumers and decomposers) is studied. The major concepts introduced are community, photosyntheses, decomposition, food transfer and recycling of raw materials.

Ecosystems: the children learn that the life processes of both plants and animals involve taking in some kind of matter and energy and giving off some other kinds. For example, the students build aquarium and terrarium systems, observe the changes in the systems then add plant eaters and then animal eaters to observe an ecosystem: a community interacting with the matter and energy that make up its environment.

The water and the carbon dioxide cycles are investigated to reveal that the interchange between organisms and their environment is a constant process and that the concentrations of the natural substances remain at relatively stable levels. Finally, the children learn that substances can become pollutants if the levels reach higher concentrations than the organisms in the ecosystem can withstand.

Nature Centers and Outdoor Education Areas.

National Audubon Society. Nature Centers Division, 1130 Fifth Avenue, New York, New York, 10028.

This portfolio is comprised of five manuals concerned with the development and use of outdoor education areas.

A Nature Center for Your Community presents arguments for the establishment of specific areas to maintain in a natural state for the purpose of preserving nature and providing enjoyment and education for people in the area which would be served by the center. A nature center is defined with its values and objectives listed. Suggestions are given for the design of the area as well as answers to questions about financing and future use.

Planning a Nature Center again discusses the purpose and value of a Nature and Conservation Center. This manual goes into detail on the aspects of initial

organizing, the appraisal of the community and resources for the choice of a site, the planning of the program and development (design of the area for intended uses and the buildings that will be needed), the educational facilities that should be available and the staffing, budgets and fund raising for the project. Ideas for use and maintenance are provided. An appendix is included with services available by the Audubon Society, sources of materials, suggestions for sign making, a sample consititutions for a nature center association and sample articles for incorporation.

Trail Planning and Layout deals primarily with actual development of a nature trail. Different kinds of trails are discussed and suggestions for educational use are given, but the emphasis is on trail design, construction and maintenance including signs, displays and guides along the way. Actual design and construction of features are thoroughly described. An appendix lists many additional sources of information and assistance.

Manual of Outdoor Conservation Education discusses the philosophy, importance and objectives of conservation education. It provides many suggestions of where, what and how to teach in an outdoor setting. The features and aids that should be present in a good educational facility are discussed as well as the necessary administration and programming of such a project.

The Manual of Outdoor Interpretation is more generally concerned with public education and appreciation of nature. Outdoor interpretation for the public is discussed as it applies to the national park system, national forests, wildlife areas, and state, county and city parks. Interpretation applies to specific areas such as nature centers, outdoor laboratories, camps, caves, underwater and the cities.

People and Their Environment: A New Concept in Conservation Education. Curriculum Guides for Teachers Grades 1 through 12. J.C. Ferguson Publishing Company, 6 North Michigan Avenue, Chicago, Illinois 60602, $3.95 each, three or more volumes for $3.50 each.

Originally it developed as the South Carolina Conservation Curriculum Improvement Project. It is designed to provide elementary, junior high and high school teachers with a background knowledge of conservation and an understanding of the principles of teaching conservation and gives the student actual experiences in conservation to help him develop an understanding of its concepts.

Each guide includes a list of sources for films and materials, a bibliography of book and pamphlets for students and teachers, a complete list of films and filmstrips and a list of the Conservation Education Association Basic Book Collections.

Each lesson includes a list of instructional materials and books, films, pamphlets, filmstrips, records, charts, illustrations and blackboard and flannel board ideas.

People and Their Environment Grades 1-2-3.

Grade 1 contains 24 lessons including those on social behavior regarding the family group, school rules and littering. Conservation is taught with the use of toys and good habits for out of doors. Nature lessons are included on such subjects as plants as a food source, birds in winter, the value of wild flowers and trees.

Grade 2 contains 19 lessons. Lessons on living things, soil, reproduction, air pollution and sounds are included. Children also sutdy the cooperation of families in a community, learning to be conservationist and conserving wildflowers.

Grade 3 consists of 13 lessons including the appreciation of the environment and various elements of conservation of wildlife, forest, soil, water and minerals. Pollution, decomposition and plant reproduction are also considered.

People and Their Environment. Grades 4-5-6.

Eighteen lessons are included in grade 4 concerning communities of plants and animals and their environmental needs. The value of various plants and animals to man is also introduced.

Grade 5 is made up of 30 lessons primarily concerned with the waste prevention of natural and human resources. Also included are lessons on practicing citizenship, the development and protection of beauty and all aspects, both fact and fanciful, about the heart.

Grade 6 includes 32 lessons on such subjects as the chemical and physical formation of matter, birds, the aesthetic value of wildflowers, heredity in hybrids, decomposers and adaptation to environment among other lessons.

People and Their Environment, Science, Grades 7-8-9.

Grade 7 includes 35 lessons dealing with life science. Lessons present such concepts as imbalance and interdependence in a pond community, predators, the effects and consequences of man's modification of the environment, prevention of erosion, seed dispersal, wetland habitats.

Grade 8 deals with earth science in 16 lessons. Soil erosion by wind and water, weather, water balance, marine resources, nitrogen and carbon dioxide in the atmosphere and the characterisitcs of a contained environment are some of the topics considered.

Physical science is the topic of the 17-lesson unit for grade 9. Sample lessons include physical and chemical changes in matter, constructive chemical changes in matter, mining, petroleum, effects of minerals in water, and nuclear energy.

People and Their Environment. Social Studies Grades 7-8-9.

This guide is made up of two sections. The "General" part consists of 44 lessons presenting an introduction to natural resources and conservation, environmental change, pollution and controls, wildlife laws and policies and man's ability to adapt.

The second section is on the "Old World" made up of 20 lessons. All aspects of resources and conservation in countries in the Old World from the British Isles, to the Balkans to Africa are discussed.

People and Their Environment. Social Studies Grades 10-11-12.

"World History" (16 lessons) includes farmers of the new stone age, Greek state and aesthetic values, basis for feudalism, demographic studies, food scarcity, etc.

"United States History" (23 lessons) includes colonists' use of the environment, westward expansion, legislation for conservation, the cost of war and peace, the law of supply and demand, etc.

"Government" (15 lessons) considers the wise use of forests, the Department of the Interior, national parks, capitalism, socialism, communism, technological progress and population growth among others.

People and Their Environment. Home Economics Grades 9-10-11-12.

Grade 9 consists of 21 lessons, examples of which are the effects of culture on children, the effects of food, children's safety, planning for nutrition, practicing safety and the importance of water.

Grade 10 deals in 24 lessons with individuals in a family, family function in maintaining cultural heritage, good citizenship, clothing and preparing a sickroom.

Grades 11 and 12 are grouped with 29 lessons including providing for senior citizens, courtship, analyzing basic needs, consumer credit and information, preventing juvenile delinquency and landscape plans.

People and Their Environment. Outdoor Classroom and Camping. All grades.

"Outdoor Laboratory" (10 lessons) includes first aid in the outdoors, water safety, sanitation, recreation, developing a nature trail, etc.

"Grades 1 through 6" (14 lessons) includes cells as building blocks, animal communities, trees as a renewable resource, wildlife conservation, etc.

"Grades 7-8-9" (21 lessons) includes the importance of forests in water control, plants to balance a community, forests, grasslands, agricultural research, etc.

"Grades 10-11-12" (11 lessons) includes classes on land capability, balance of nature, community population studies, plant succession in a pond and succession on sand dunes.

People and Their Environment. Biology.

(43 lessons) includes the oxygen cycle, plant and animal relationships, producer-consumer relationships, paratism, population factors, man's adaptibility biomes, forest communities, ocean communities, water pollution, and the aesthetic value of birds among others.

Interaction Science Curriculum Project

A series of junior high science programs, one life science and one physical science. School Department, Rand McNally and Company, (1970,1971) 206 Sansome Street, San Francisco, California 94104.

Interaction of Man and the Biosphere is a junior high text book which incorporates activities dealing with the life sciences. A Teacher's Guide is also available with the text. Three themes are presented by the text: 1. The biosphere is a complex balance of interactions rather than a resource without limit. 2. Since man is part of the biosphere, he must maintain a balance in the environment to exist. 3. Many variables are involved with maintaining balance so knowledge is essential for the identification of the relevant variables.

An inquiry approach is used by having students observe living things and their behavior, encouraging them to form their own impressions. The student's edition is integrated investigation and text, with the text providing basic knowledge essential for clear thinking, but not the answers to the problems. The teacher's ediction contains both student material and suggestions for the teacher.

The text consists of 12 sections which cover life in the biosphere, investigating an interaction, interactions within organisms, transport problems, how food is used, internal balance, man's interaction with nature, ecological interactions, organisms in the biosphere, reproduction, genetics and change through time.. An appendix gives additional information on working with a microscope, making collections and the growth and care of organisms.

The second of the series is Interaction of Matter and Energy which follows the same approach dealing with the physical sciences.

Elementary Science Study

Webster Division of McGraw-Hill Book Company. Manchester Road, Manchester, Missouri 63011

It consists of a wide variety of science units for elementary students. Teacher's guides, student books, supplementary books, materials, films and film loops have been developed and are available for use in the program. No specific order is suggested. The teacher can use the units as she wishes. A suggested grade level is listed to help in applying the unit though it can be adapted to any grade level. Units are available for many areas of the sciences and many, particularly those in the life sciences, would be applicable to an environmental studies program. The following are some examples of life science units.

The Life of Beans and Peas is a unit developed for the primary level which guides children in growing peas and beans through several life cycles. Investigations are developed around this growth.

Brine Shrimp is another unit for the primary grades. Younger children will learn from investigating all phases of the life cycle of the brine shrimp. A number of experiment ideas are given for older children.

Animal Activity for middle grade students in particular provides the students with experience in keeping records, figuring time intervals, computing averages, constructing graphs and analyzing data while investigating the activity of small animals such as hamsters, mice or gerbils.

Behavior of Mealworms teaches children how to carry out an investigation as they learn, through the process of scientific inquiry, about the sensory perception of the mealworm. Undirected observations lead the students to their own elementary experiments.

Bones takes advantage of children's natural curiosity about bones. The guide gives suggestions for activities such as identifying bones and assembling skeletons, but leaves daily procedures up to the teacher and the class.

Small Things introduces the microscopic world and instruments to children through an exploration of cells, crystals and microscopic organisms. Each investigation is thoroughly planned, but the students must find the answers to their questions.

Pond Water teaches the skills of observation in a study of the variety of life in pond water. They learn of the interactions of pond life and learn to identify some of the plants and animals.

Crayfish provides another opportunity for learning the skills of observation and investigation as the children learn to care for crayfish and carry out activities with them.

Budding Twigs gives children an opportunity to examine the structure of twigs and the development of buds forced to bloom ahead of season. This gives the students a chance to closely examine a small part of the world involving their senses and minds.

An Outline for Teaching Conservation in Elementary Schools. U.S. Department of Agriculture. Soil Conservation Service. PA-268. Also an outline available for junior and senior high schools. It was developed to serve as a general guide to be adapted by the teachers and pupils to local conditions. The emphasis is on the conservation of soil and water, but brings in the conservation of other resources.

Each grade level section is divided into objectives, discussion ideas, suggested activities, and a space for notes. Also included are sections on visual teaching aids, references and books for the teacher or advanced students.

Man and His Environment, the Coca Coca Company. Gives students an opportunity to "plan" a city in any way they wish with a map and figures of houses, wildlife, etc. This serves to teach the students about the planning necessary to preserve the environment and introduces some of the social problems of a community.